University of Oklahoma

Gallogly College of Engineering
School of Computer Science

CS G4323: Compiler Constructions

Spring 2025

Instructor: Dr. Richard Veras (richard.m.veras@ou.edu)

Course Format: In Person

Time: Noon – 1:15PM Tuesday and Thursday

Exam: 5/6/2025 1:30PM-3:30PMAM

Location: Carson Engineering Center 117

Office Hours: Wednesday 9:00AM-10:00AM

Office Hours Location: DEH 210-C (Send an email when you get to the outer door)

Teaching Assistant: Kendall Tauser (kendall.tauser@ou.edu)

TA Office Hours: TBD

TA Office Hours Location: TBD

Learning Management System/website: canvas.ou.edu

Course Prerequisite: CS 2413 or CS 2414, and CS 3823

Course Description:

Introduction to the theory and implementation of programming language compilers and interpreters. Class projects require the design of medium-scale software systems.

Lectures will be a mix of traditional lectures, in-class lab time, class discussions, videos and other activities. Participation is required to get the most out of the class. Class projects/labs/assignments will require the design and implementation of complex software systems. A UNIX family operating system will be used along with the GNU Toolchain for most assignments.

Course Goals:
This course is meant to provide an experience for the students to view programming as a goal-oriented process. A major component of this course will be learning from one another through challenging open-ended team assignments. Here students will be challenged to think creatively to synthesize potential solutions, devise testing strategies and integrate these solution into their implementations.

Learning Outcomes: By the end of the semester, the students will be able to apply computer science theory and software development fundamentals to produce computing-based solutions. For more information, see http://www.abet.org.

- Explain the various stages of a modern compiler infrastructure.
- Analyze intermediate code with the goal of enabling optimizations.
- Analyze contemporary papers in compiler research.
- Explain the intersection of application, languages, optimizations, hardware and automation.
- Communicate technical knowledge in this domain.
- Develop compiler stages and transformations.
- Develop a medium scale compiler project.

ABET Student Outcomes: By the end of the semester, the students will have:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to communicate effectively with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Texts and Materials:

The required text is “Essentials of Compilation: An incremental Approach in Python.” Jeremy Siek.

This text is publicly available and the LaTeX sources can be downloaded and compiled:

```
git clone https://github.com/IUCompilerCourse/Essentials-of-Compilation.git

cd Essentials-of-Compilation/

make
```

Alternatively, you can upload the files in that repository to overleaf and it will compile.

Finally, a pre-rendered Racket version can be found on the author's course page. This is the same book but with code examples in a different language that might be more readable to some:

https://iucompilercourse.github.io/IU-P423-P523-E313-E513-Fall-2020/

Teaching Philosophy & Inclusion Statement:

This course revolves heavily around group assignments to encourage peer learning. Your peers will continue to be your peers beyond graduation. It is my goal to create an environment that encourages the strengthening of the bonds between you and your peers.

Learning Activities, Assignments, and Assessment:
The work in this course will be divided into several components including: homework assignments (HW), programming assignments (PG), labs, participation activities, and an individual long-term project.

Homework will consist of regular written assignments covering the material in the book and may include some coding.

The **programming assignments** will dig deeper into the practical aspects of the homework concepts that will be used in the labs. These will involve a mix of external readings for context, running through examples, and implementing code.

Labs will be the main driver of the material and will utilize the majority of the in-class time. Randomized teams will be tasked with bridging the material from the homework and programming assignments to solve practical problems with compiler techniques. Team members will have specific roles, work together, and divide points amongst each other. Much of the work for the lab will be done in class, so attendance is required and unexcused absences will be heavily penalized.

The **individual project** will be primarily a written report developed over the bulk of the semester to demonstrate your understanding of the material. There will be multiple incremental deliverables throughout the semester.

Participation is a category for a variety of planned, semester long, or ad-hoc events that are in support of your peers' education. This category consists of 10% of your grade that is achieved through 10 points of

activities. For example, finding and documenting a bug in an assignment is 1-point. Organizing an in-person study group for a programming assignment is 2-points (a remote one is 1-point). Attending an in-person study group is 2-points (1-point remote). Uploading chapter notes (or any course reading) is 1-point. Applying for compiler-related jobs (there will be very specific instructions) is 1-point per posting. Attending OU CS related events will be a variable number of points. A large – and valuable – component of your education extends beyond the content of the classroom and the goal of this category is to catalyze the sorts of interactions that add value to your degree.

Assigning Grades: (The grade on canvas may not reflect your actual grade as it does not factor missing grades/categories/weights. When in doubt compute your grade based on these weights.)

Category	**CS G4323**
Programming Assignments	25
Reading Assignments	15
Participation	10
Lab	40
Individual Project	10
Total	***100***

Grading Scale:

The letter grade thresholds will be no higher than the following; they may be lower at the discretion of the instructors.

Grade	Points (P)
A	P>=90
B	80>=P>90
C	70>=P>80
D	60>=P>70
F	P<60

Schedule of Topics (Subject to change)

week	**Topic (HW Friday)**	Programming (M)	Lab (W)
1	Introduction and Preliminaries	Preliminaries I	
2	Integers and Variables	Preliminaries II and III	Out: String Matcher
3	Parsing	Low-Level Coding	
4	Register Allocation	Loop Transforms	Due: String Matcher Out: Halide-like
5	Booleans and Conditionals	Register Counting	
6	Loops and Data Flow	Scheduling I	
7	Tuples and Garbage Collection	Scheduling II	

8	Functions	Brute-Force	Due: Halide-like Out: Super-Optimizer
9	Lexically Scoped Functions	Formal Verification	
10	Dynamic Typing	Scheduling III	
11	Gradual Typing	Scheduling IV	
12	Generics	Term Rewriting	Due: Super-Optimizer Out: Design Space Explorer
13	LLVM Front-end I	Kaleidoscope	
14	LLVM Front-end II	Kaleidoscope	
15	LLVM Optimization Pass	First Pass	
16	LLVM Backend	CPU0	Due: Design Space Explorer

Course Policies

Academic Integrity and Plagiarism

Cheating is prohibited at the University of Oklahoma, because it devalues the degree you are working hard to get. As a member of the OU community, it is your responsibility to protect your educational investment by knowing and following the rules. For specific definitions on what constitutes cheating, review the Student's Guide to Academic Integrity at: http://integrity.ou.edu/students_guide.html

To be successful in this class, all work on exams, quizzes and homework must be yours and yours alone. You may not receive outside help. Be aware that it is my professional obligation to report academic misconduct, which I will not hesitate to do. Sanctions for academic misconduct can include expulsion from the University and an F in this course, so do not cheat. It is simply not worth it.

Absences

You are expected to attend class and actively participate in the exercises and discussions. This includes being prepared to work and engaged with your group on lab days. In cases of sickness, and quarantine alert you instructor before the class period via email, in case we need to discuss alternative arrangements. Additionally, you will be required to submit an absence form on canvas for each absence. These forms will be reviewed before the end of the semester. You will be allowed two (2) free absences throughout the semester. Absences beyond that may count against your participation score or your lab grade during lab days. If you are absent without prior documentation on the first day of the lab you will not be assigned to a team until you reach out to

the instructor and TA. If you have excessive un-documented absences during a lab, you can be removed from your lab team.

Late Assignments

Each assignment may contain a grading scale for late submissions. Beyond that, except cases of sickness or provost approved activities, late work will not be accepted. These cases must be documented ahead of time in an absence form.

Grading

Submissions will be scored against a rubric and not against other submissions. We can only grade what is submitted. The resulting grade reflects the quality of the submission, not the individual. If you believe there is an issue with a score to your assignment, with respect to the instructions, rubric, or syllabus, then you may submit a regrade request. If the request is approved, then a regrade of the assignment will occur before final grades are due. The instructor will decide if either part of the assignment will be re-graded, or the entirety. If uncaught mistakes are found, they will be scored as such. If uncaught evidence of academic dishonesty is found, those will be reported as such. Other than professionalism points, there will be no additional extra credit.

Professionalism Points

In certain assignments there will be opportunities to earn additional points. These will be explicitly enumerated in the assignments and aim to highlight professional behavior in the field. These points may be invalidated through unprofessional behavior at the assignment level or the course level. These points are designed to reward additional effort and reinforce professional behavior in your work and conduct. Behaviors that bypass effort or attempt to undermine the course will not receive that reward.

Generative AI

Unless an activity explicitly allows it, you are not allowed to use Generative AI tools on your assignments. This includes LLM-based code and grammar assistants.

Graduate Section

In the graduate section of the course you and your team will present your work at a departmental poster session. This will occur during the Thursday or Friday of dead week. Your team will be responsible for being present during the session.

University Masking Guidelines: The university encourages masking indoors. The university strongly encourages masking for all individuals in high-density settings, such as classrooms and at special events.

Land Acknowledgement Statement Provided by OU's Tribal Liaison office:
Long before the University of Oklahoma was established, the land on which the University now resides was the traditional home of the "Hasinais" Caddo Nation and "Kirikirʔi:s" Wichita & Affiliated Tribes.

We acknowledge this territory once also served as a hunting ground, trade exchange point, and migration route for the Apache, Comanche, Kiowa and Osage nations. Today, 39 tribal nations dwell in the state of Oklahoma as a result of settler and colonial policies that were designed to assimilate Native people. The University of Oklahoma recognizes the historical connection our university has with its indigenous community. We acknowledge, honor and respect the diverse Indigenous peoples connected to this land. We fully recognize, support and advocate for the sovereign rights of all of Oklahoma's 39 tribal nations. This acknowledgement is aligned with our university's core value of creating a diverse and inclusive community. It is an institutional responsibility to recognize and acknowledge the people, culture and history that make up our entire OU Community.

Expectations for Academic Integrity:

Cheating is prohibited at the University of Oklahoma, because it devalues the degree you are working hard to get. As a member of the OU community, it is your responsibility to protect your educational investment by knowing and following the rules. For specific definitions on what constitutes cheating, review the Student's Guide to Academic Integrity at: http://integrity.ou.edu/students_guide.html

To be successful in this class, all work on exams, quizzes and homework must be yours and yours alone. You may not receive outside help. Be aware that it is my professional obligation to report academic misconduct, which I will not hesitate to do. Sanctions for academic misconduct can include expulsion from the University and an F in this course, so do not cheat. It is simply not worth it.

University Policies

Copyright Syllabus Statement:

Sessions of this course may be recorded or live-streamed. These recordings are the intellectual property of the individual faculty member and may not be shared or reproduced without the explicit, written consent of the faculty member. In addition, privacy rights of others such as students, guest lecturers, and providers of copyrighted material displayed in the recording may be of concern. Students may not share any course recordings with individuals not enrolled in the class or upload them to any other online environment.

Religious Observance

It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty.

Reasonable Accommodation Policy

Students requiring academic accommodation should contact the Accessibility and Disability Resource Center for assistance at (405) 325-3852 or TDD: (405) 325-4173. For more information

please visit http://www.ou.edu/drc/home.html. Any student in this course who has a disability that may prevent them from fully demonstrating his or her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

Title IX Resources and Reporting Requirement

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at 405/325-2215 (8 to 5, M-F) or smo@ou.edu. Incidents can also be reported confidentially to OU Advocates at 405/615-0013 (phones are answered 24 hours a day, 7 days a week). Also, please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies can be directed to University Equal Opportunity Officer and Title IX Coordinator at 405/325-3546 or smo@ou.edu . For more information, visit http://www.ou.edu/eoo.html.

Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your professor or the Disability Resource Center at 405/325-3852 as soon as possible. Also, see http://www.ou.edu/eoo/faqs/pregnancy-faqs.html for answers to commonly asked questions.

Emergency Protocol

During an emergency, there are official university procedures that will maximize your safety.

Severe Weather: If you receive an OU Alert to seek refuge or hear a tornado siren that signals severe weather *1. LOOK* for severe weather refuge location maps located inside most OU buildings near the entrances *2. SEEK* refuge inside a building. Do not leave one building to seek shelter in another building that you deem safer. If outside, get into the nearest building. *3. GO* to the building's severe weather refuge location. If you do not know where that is, go to the lowest level possible and seek refuge in an innermost room. Avoid outside doors and windows. *4.* GET IN, GET DOWN, COVER UP. 5. *WAIT* for official notice to resume normal activities.

Link to Severe Weather Refuge Areas , *Severe Weather Preparedness - Video*

Armed Subject/Campus Intruder:

If you receive an OU Alert to shelter-in-place due to an active shooter or armed intruder situation or you hear what you perceive to be gunshots:

1. GET OUT: If you believe you can get out of the area WITHOUT encountering the armed individual, move quickly towards the nearest building exit, move away from the building, and call 911. *2. HIDE OUT*: If you cannot flee, move to an area that can be locked or barricaded, turn off lights, silence devices, spread out, and formulate a plan of attack if the shooter enters the room. *3. TAKE OUT*: As a last resort fight to defend yourself.

For more information, visit http://www.ou.edu/emergencypreparedness.html

Shots Fired on Campus Procedure - Video

Fire Alarm/General Emergency:

If you receive an OU Alert that there is danger inside or near the building, or the fire alarm inside the building activates: *1. LEAVE* the building. Do not use the elevators. *2. KNOW* at least two building exits *3. ASSIST* those that may need help *4. PROCEED* to the emergency assembly area *5 ONCE safely outside, NOTIFY first responders of anyone that may still be inside building due to mobility issues. 6. WAIT* for official notice before attempting to re-enter the building.

OU Fire Safety on Campus

Mental Health Support Services:

If you are experiencing any mental health issues that are impacting your academic performance, counseling is available at the University Counseling Center (UCC). The Center is located on the second floor of the Goddard Health Center, at 620 Elm Rm. 201, Norman, OK 73019. To schedule an appointment call (405) 325-2911. For more information please visit http://www.ou.edu/ucc.