

University of Oklahoma
Galogly College of Engineering
School of Computer Science

CS G4323: Compiler Construction
Spring 2024

Instructor: Dr. Richard Veras

Course Format: In-Class

Time: 11:30 AM – 12:20AM Tuesday and Thursday

Location: Carson Engineering Center, Room 0117

Exam: 1/19/2038 Monday 2:14AM-3:14AM

Office Hours: 10:30AM-11:30AM Tuesday and Thursday

Office Hours Location: Devon Energy Hall, Room 210

Teaching Assistant: 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:

No text is required.

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 inclusive classroom that encourages the strengthening of the bonds between you and your peers.

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 "Hasinai" Caddo Nation and "[Kirikirʔi:s](#)" (audio available when opened in Chrome) 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.

Learning Activities, Assignments, and Assessment:

The work in this course will be divided into several components including: homework assignments, group programming assignments, exams, and participation activities.

Homeworks will consist of regular written assignments covering the material in class. The group programming assignments will include a warmup component that involves working through examples for the given topic, followed by a competition component where teams will optimize an operation with respect to a given metric and compete against other teams. Team members will be randomized for each programming assignment and will be graded on mastery of material and team effort. A midterm and a final exam will cover the material in the lectures and lab assignments to assess your understanding of the content. Participation will include activities such as engaging in class discussion, being a designated note taker for a lecture, creating tool tutorials, and being a weekly grader assistant.

Graduate students taking this course as CS5473 will have additional assignments (beyond those required for CS4473).

Assigning Grades:

- Lecture Assignments: 10%
- Programming Assignments: 20%
- Paper Assignments 20%
- Projects/Labs: 40%
- Participation: 10%

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.

Late Assignments

Except in the cases of sickness or provost approved activities, late work will not be accepted.

Absences

You are expected to attend class and actively participate in the exercises and discussions. In cases of sickness, and quarantine alert you instructor before the class period (email) and we will discuss alternative arrangements.

Technology

All students enrolled in class should also have a CS account and access to a Linux-based systems in the CS department. For most computer science students, an account will be automatically created. All code written for this course MUST run using the compilers or interpreters that will be specified for the assignments. It is your responsibility to ensure that your code runs on these systems. For compatibility reasons, we recommend developing and testing on a Linux-based machine.

University Policies

In this section, include the mandatory and recommended University policies.

Copyright Syllabus Statement for In-Person or Online Courses

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.

Academic Integrity

Academic honesty is incredibly important within this course. Cheating is strictly 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](#).

To be successful in this class, all work on exams and quizzes must be yours and yours alone. You may not receive outside help on assessments. On examinations and quizzes, you will never be permitted to use your notes, textbooks, calculators, or any other study aids. Should you see someone else engaging in this behavior, I encourage you to report it to myself or directly to the Office of Academic Integrity Programs. I encourage this because when someone else cheats, it can negatively impact the reputation of our entire program. 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 don't cheat. It's simply not worth it.

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. [\[See Faculty Handbook 3.15.2\]](#)

Reasonable Accommodation Policy

The Accessibility and Disability Resource Center is committed to supporting students with disabilities to ensure that they are able to enjoy equal access to all components of their education. This includes your academics, housing, and community events. If you are experiencing a disability, a mental/medical health condition that has a significant impact on one or more life functions, you can receive accommodations to provide equal access. Possible disabilities include, but are not limited to, learning disabilities, AD(H)D, mental health, and chronic health. Additionally, we support students with temporary medical conditions (broken wrist, shoulder surgery, etc.) and pregnancy. To discuss potential accommodations, please contact the ADRC at 730 College Avenue, (ph.) 405.325.3852, or adrc@ou.edu.

Title IX Resources and Reporting Requirement

Anyone who has been impacted by gender-based violence, including dating violence, domestic violence, stalking, harassment, and sexual assault, deserves access to resources so that they are supported personally and academically. The University of Oklahoma is committed to offering resources to those impacted, including: speaking with someone confidentially about your options, medical attention, counseling, reporting, academic support, and safety plans. If you would like to speak with someone confidentially, please contact [OU Advocates](#) (available 24/7 at 405-615-0013) or another confidential resource (see [“Can I make an anonymous report?”](#)). You may also choose to report gender-based violence and discrimination through other means, including by contacting the [Institutional Equity Office](#) (ieo@ou.edu, 405-325-3546) or police (911). Because the University of Oklahoma is committed to the safety of you and other students, I, as well as other faculty, Graduate Assistants, and Teaching Assistants, are mandatory reporters. This means that we are obligated to report gender-based violence that has been disclosed to us to the Institutional Equity Office. This includes disclosures that occur in: class discussion, writing assignments, discussion boards, emails and during Student/Office Hours. For more information, please visit the [Institutional Equity Office](#).

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 Accessibility and Disability Resource Center at 405/325-3852 as soon as possible. Also, see the Institutional Equity Office [FAQ on Pregnant and Parenting Students' Rights](#) for answers to commonly asked questions.

Final Exam Preparation Period

Pre-finals week will be defined as the seven calendar days before the first day of finals. Faculty may cover new course material throughout this week. For specific provisions of the policy please refer to OU's [Final Exam Preparation Period policy](#).

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.

Additional [Weather Safety Information](#) is available through the Department of Campus Safety.

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. *Avoid:* 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. *Deny:* 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. *Defend:* As a last resort fight to defend yourself.

For more information, visit [OU's Active Shooter page](#).

[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 [University Counseling Center](#).

Pre-Finals Week Policies

During pre-finals week, all normal class activities will continue; however, no assignment, test, or examination accounting for more than 3% of the course grade may be assigned, unless it is assigned in advance of pre-finals week and worth less than 10%, or scheduled at least 30 days prior if worth more than 10%. No activity or field trip may be scheduled that conflicts with another class. There are some exceptions and nuances, so please review the [Final Exam Policies](#) prior to designing your course schedule.

Tentative Schedule (Subject to change)

We will be following the lectures from the following:

<https://www.cs.cornell.edu/courses/cs6120/2023fa/self-guided/>

Week	Topic	Reading (Mon)	Programming (Friday)	Labs (Wed)
1	Representing Programs			
2	Local Analysis and Optimizations		Tools I	
3	Dataflow	RD 1 Due		
4	Global Analysis		Tools II	
5	Static Single Assignment			Lab 1: Peephole
6	LLVM		Tools III	
7	Loop Optimizations	RD 2 Due		
8	Interprocedurally Analysis		LLVM "Kaleidoscope" pt 1	
Break	Break			
10	Alias Analysis		LLVM "Kaleidoscope" pt 2	Lab 2: Super Optimizer
11	Memory Management			
12	Dynamic Compilers	RD 3 Due	MLIR "Toy" pt 1	
13	Program Synthesis			
14	Concurrency and Parallelism		MLIR "Toy" pt 2	
15	Future Directions			Lab 3: DSL
16	Presentations	RD 4 Due		