

ASEN 4057 Aerospace Software

Material is preliminary and subject to change

Instructor: Alexandra Le Moine (Alexandra.LeMoine@colorado.edu)

Lecture: Tuesday/Thursday 8:30-9:20am, Aero N100 (CoPilot)

Lab: Tuesday/Thursday 9:35-10:25am, Aero N100 (CoPilot)

TF:

Course Objectives

The purpose of this course is to equip aerospace engineering students with practical, industry-relevant software development skills used in scientific and engineering computing environments. These skills are widely used in modern aerospace workflows, including CFD, flight software tooling, spacecraft guidance and navigation algorithms, satellite autonomy and robotics, on-board telemetry processing, and ground-segment software workflows. The course emphasizes the full software development lifecycle – Linux environments, version control, modular design, memory- and cache- efficient programming, debugging, code profiling, and build automation.

Course Learning Goals

By the end of this course, students will:

1. Gain fluency in Linux-based development environments and remote computing workflows via the terminal.
2. Apply industry-standard version control practices using command-line Git and GitHub.
3. Implement systems-level C-programming techniques, emphasizing memory layout, pointer usage, and efficient data structures.
4. Interpret profiler output to diagnose performance bottlenecks and apply cache-aware optimization strategies to reduce memory stalls.
5. Build and link modular C programs using Makefiles and compiler optimization flags.
6. Utilize scientific libraries for high-performance computing.
7. Automate repetitive tasks and orchestrate data pipelines using shell scripting.

Prerequisites

Students should have proficiency in programming fundamentals for a high-level programming language (e.g., C, C++, FORTRAN, MATLAB, Python, etc.). It is assumed that students in the course have taken ASEN 1030 (previously ASEN 1320) or CSCI 1300 and it is strongly suggested that students also have taken CSCI 2270. Previous experience with C programming is recommended but not mandatory. Curiosity along with a willingness to adapt previous programming knowledge to learn the C Programming language is required.

Course Textbook, References and Material

There is no textbook required for the course. Instead, reference material will be suggested throughout the course as applicable to the current lecture/assignment topics.

Course Topics

1. Fundamentals of Scientific Software Design
2. Linux Development Environment & Remote Computing
3. Version Control using Git & GitHub
4. C Programming for Scientific Software
5. Shell Scripting in BASH
6. Build Automation using Makefiles
7. Compiler Optimization
8. Cache-Aware Algorithm Optimization
9. Scientific Libraries using BLAS & LAPACK

Course Format

The course will follow a blend of traditional lectures with lab/computing assignments. There will be two lectures and two lab periods per week with lab immediately following lecture. Each lab will contain an activity that is expected to be completed by the end of lab. There will be 4 individual mini programming projects in addition to a final project. Student assessment will be based on lab activities, mini projects, and the final project.

Course Grading

40% Lab Activities

40% Mini Projects

20% Final Project

Grades will be posted to the course website on Canvas.

Lab Activities

Lab activities are hands-on coding and software workflow exercises completed during lab and are designed to reinforce lecture concepts. A lab activity is assigned every class, making participation a regular and expected component of the course. Lab activities must be completed and submitted by the end of the lab. **No late lab activities will be accepted.**

The use of Generative AI or any AI-powered inline code completion tool is strictly prohibited for all Lab Activities.

Lab activities are graded pass/fail based on functional completion of required tasks and submission through the specified GitHub workflow. To accommodate occasional technical or attendance disruptions, **the lowest two lab activity grades will be dropped at the end of the semester.**

Mini Projects

Mini projects are programming assignments which are typically longer than traditional homework assignments but shorter than the final project. Mini Projects scaffold multiple topics together and require students apply what they have been learning in lecture to complete the required assignments. **Mini Projects are individual programming assignments** and require a mandatory interview with the instructor to verify authorship of submitted work. Mini projects will be graded using the course rubric along with the outcome of the oral interview. **No late submissions will be accepted.**

Final Project

A final project will replace a final exam and is due prior to the last week of the semester. **The final project is an individual programming assignment** and requires a mandatory interview with the instructor to verify authorship of submitted work. The final project will be graded using the course rubric along with the outcome of the oral interview. **No late submissions will be accepted.**

Project Interviews & Authorship

Students are required to maintain 100% authorship for all work submitted in this class. To verify authorship, students will be required to participate in oral interviews with the course instructor for most of the project assignments. During these interviews, the course instructor will ask specific questions regarding the design, implementation, logic, and coding principles of individual project submissions. Interview questions are tailored to individual submissions and at the sole discretion of the instructor. **Failure to maintain 100% authorship of submitted work will result in an automatic course failure and a submission to the CU Honor Board for an Academic Integrity Violation.**

Apart from the final project interview, all mini project interviews will be held at a scheduled time outside of lecture/lab and will be approximately 10-20 minutes in duration. The instructor will prepare scheduling opportunities throughout the semester for each student to sign up for their interviews. During the interview, students may not access their computer or course notes. If there is a specific question that requires looking at the code, the instructor will provide the code. During the oral interview, students are encouraged to use the whiteboard to support explanations and/or provide clarification.

Students are only allowed one attempt at each authorship interview.

Generative AI Policy

For the first 6 weeks of this class, the use of Generative AI in any supportive manner is strictly prohibited and failure to comply with this policy will result in an automatic letter grade failure of the course. After a series of lectures regarding Generative AI use in software development, students will be allowed to make use of Generative AI within a limited capacity for the remaining projects. **Please note that Generative AI will remain strictly prohibited for all lab activities.**

Appropriate Generative AI usage on allowed assignments is limited to (1) debugging assistance, (2) clarifying concepts, and/or (3) refactoring suggestions. Using Generative AI to produce code for you to copy in any capacity is a violation of the Generative AI Policy.

When making use of Generative AI in the capacity mentioned, it is required to provide clear and explicit citations with project submissions. Citation formatting will be discussed in class, and a template will be provided.

CU BOULDER POLICIES

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the [Honor Code](#). Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. Understanding the course's syllabus is a vital part of adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code will be assigned resolution outcomes from Student Conduct & Conflict Resolution and will be subject to academic sanctions from the faculty member. Visit [Honor Code](#) for more information on the academic integrity policy.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or DSinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

If you have a temporary illness, injury or required medical isolation for which you require adjustment, please contact the course instructor immediately for further information.

Accommodation for Religious Obligations

Instructional faculty members must make every reasonable effort to accommodate all students who have conflicts with scheduled exams, assignment deadlines or required attendance due to a religious observance. Whenever possible, students must notify the instructional faculty member at least two weeks in advance of the expected exam, assignment deadline, or attendance conflict to request an accommodation for religious observance. If the start date of the course is less than two weeks before the date of requested accommodation, students must notify the instructional faculty member on the start date of the course. [See the Student Academic Accommodations for Religious Observances Policy](#) for more information.

In this class, please contact the course instructor immediately for further information.

Student Names and Pronouns

CU Boulder recognizes that students' legal information does not always align with how they identify. If you wish to have a name other than your legal name appear on your instructors' class rosters and in Canvas, or if you wish to choose pronouns to appear on your instructors' class rosters and in Canvas, visit the [Registrar's website](#) for instructions on how to change your personal information in university systems.

Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to

discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, marital status, political affiliation, or political philosophy.

Additional classroom behavior information

- [Student Classroom and Course-Related Behavior Policy](#).
- [Student Code of Conduct](#).
- [Office of Institutional Equity and Compliance](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering a productive and welcoming learning, working, and living environment. University policy prohibits [protected-class](#) discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- or off-campus. Denial of an approved accommodation for disability, religious observance, or pregnancy or pregnancy related medical conditions may be discriminatory.

The [Office of Institutional Equity and Compliance \(OIEC\)](#) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email OIEC@colorado.edu. Information about university policies, [OIEC reporting options](#), and [OIEC support resources](#) including confidential services can be found on the [OIEC website](#).

Faculty and graduate instructors are required to inform OIEC when someone discloses misconduct regardless of when or where it occurred. This is to ensure that those impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support options for a variety of concerns, visit the [Don't Ignore It page](#).

Mental Health and Wellness

The University of Colorado Boulder is committed to supporting students' mental health and overall wellbeing. If personal, academic, or emotional challenges are affecting your wellbeing or success, [Counseling and Psychiatric Services \(CAPS\)](#), is here to help. CAPS offers counseling, referrals, psychiatric care, crisis support, and much more. Visit CAPS in the C4C, or call (303) 492-2277, 24/7.