

# ASEN 4057 Aerospace Software

*Material is preliminary and subject to change*

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**Lecture:** Monday/Wednesday 3:00-3:50pm, Aero N240

**Lab:** Monday/Wednesday 4:05-4:55pm, Aero N240

## 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, code profiling, build automation, and shared-memory parallelism.

## 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, including collaborative development through pull requests.
3. Use MATLAB for rapid scientific prototyping and GUI development.
4. Implement systems-level C-programming techniques, emphasizing memory layout, pointer usage, and efficient data structures.
5. Interpret profiler output to diagnose performance bottlenecks and apply cache-aware optimization strategies to reduce memory stalls.
6. Build and link modular C programs using Makefiles and compiler optimization flags.
7. Leverage scientific libraries for high-performance computing.
8. Parallelize shared-memory numerical workloads using OpenMP and evaluate scaling performance empirically.

## Prerequisites

Students should have an extensive background in MATLAB programming and should understand programming fundamentals in C or C++. It is assumed that students in the course have taken ASEN 1320 or CSCI 1300 and it is suggested that students also have taken CSCI 2270. Previous experience with C programming is recommended.

## 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. MATLAB for Scientific Prototyping
5. MATLAB GUI Development
6. C Programming for Scientific Software
7. Build Automation using Makefiles
8. Compiler Optimization
9. Cache-Aware Algorithm Optimization
10. Scientific Libraries using BLAS & LAPACK
11. Shared-Memory Parallelism with OpenMP

## 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. Each lab will contain an activity that is expected to be completed during the lab time. There will be 4 individual programming/homework assignments. A final project will replace a final exam. Student assessment will be based on lab activities, assignments, and the final project.

## Course Grading

40% Lab Activities

40% Homework Assignments

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 class and reinforce lecture concepts through implementation, debugging, performance measurement, and build discipline. A lab activity is assigned every lecture day, making participation a regular and expected component of the course. Labs 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.**

## Homework Assignments

All homework assignments and lab work will be submitted to your private GitHub repository owned by the Aerospace Software course organization. Starting with Homework #3, submissions must be made through Pull Requests (PR) into the **main branch**, demonstrating a meaningful and sequential commit history. Earlier homework assignments may be committed directly to the main branch.

Collaboration is permitted at the conceptual and debug strategy level, but code copying, repository sharing, or AI-generated submissions without attribution is not allowed. Generation AI may be used to assist with debugging, refactoring, or conceptual questions, but it may not be used to produce final submitted code. Any AI assistance that meaningfully contributes to submitted code must be acknowledged in comments or documentation.

**Late submissions will not be accepted for this course.**

**Homework Submission Guidelines**

All homework submissions must contain the following items:

- A clear README describing design decisions, program structure, testing, and performance results where applicable.
- Well-commented and modular code.
- Follow the course-specific style-guide.
- A coherent commit history showing progressive development (>5 commits is recommended unless otherwise specified).
- All requested outputs exactly as produced by the program (no approximations, early terminations, or added text).

Students must ensure their final submission:

- Compiles and runs without errors.
- Produces correct numerical or console outputs.
- Includes no extra print statements beyond those required.
- Contains no unacknowledged external code courses.

**Final Project**

A final project will replace a final exam and will be assigned toward the end of the semester and due on the last day of the semester prior to Reading Day.

## CU BOULDER POLICIES

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### 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](mailto: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](mailto: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, you must alert your professor immediately via email per the communications policy listed in section III.

### Accommodation for Religious Obligations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, you must alert your professor immediately via email per the communications policy listed in section III. See the [campus policy regarding religious observances](#) for full details.

### Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information does not always align with how they identify. If you wish to have your preferred name (rather than your legal name) and/or your preferred pronouns 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.](#)
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### **Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation**

CU Boulder is committed to fostering an inclusive 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- and off-campus. 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](mailto:OIEC@colorado.edu). Information about university policies, [reporting options](#), and [OIEC support resources](#) including confidential services can be found on the [OIEC website](#).

Please know that faculty and graduate instructors are required to inform OIEC when they are made aware of incidents related to these concerns regardless of when or where something occurred. This is to ensure the person impacted receives outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the [Don't Ignore It](#) page.

### **Mental Health and Wellness**

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact [Counseling and Psychiatric Services \(CAPS\)](#) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through [Academic Live Care](#). The [Academic Live Care](#) site also provides information about additional wellness services on campus that are available to students.