

# ASEN 4057 Aerospace Software

*Material is preliminary and subject to change*

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

**Lecture:** Monday/Wednesday 2:45-3:35pm, Aero N100 (COPILOT)

**Lab:** Monday/Wednesday 3:45-4:35pm, Aero N100 (COPILOT)

**Office Hour:** Friday 3-4 pm, Aero N209

**TA:** Connor O'Reilly (connor.t.oreilly@colorado.edu)

**TA Office Hour:** TBD

**Canvas Webpage:** <https://canvas.colorado.edu/courses/80590>

**Github Private Repos:** <https://github.com/Aerospace-Software>

## Course Objectives

Aerospace engineers may go through their entire undergraduate education curriculum and have only a single formal course in *computing*, which often does not even cover formal programming, much less

## Course Topics

### 1. Fundamentals of Computer Programming and Software Design

#### 2. MATLAB as a Tool for Software Design

- a. Review of Basic Concepts
  - i. Classes, Arrays, Computations
  - ii. If Statements
  - iii. While and For Loops
  - iv. Plotting
  - v. Scripts and Functions
- b. Advanced MATLAB Concepts
  - i. Debugging
  - ii. Profiling
  - iii. Numerical Integration and Optimization
  - iv. Handle Graphics
  - v. GUI Development

#### 3. Moving Beyond MATLAB

- a. Compiled Languages versus Interpreted Languages
- b. Basic Sequential Computer Architectures and Operating Systems

#### 4. Introduction to Unix/Linux

- a. Bash and Command Line Interface
- b. Bash Programming

#### 5. Version Control and Git

#### 6. C as a Tool for Software Design

- a. Review of Basic Concepts
- b. Pointers and Memory Management
- c. Compilation and Linking
- d. Building Programs with Make
- e. Defensive Programming and Debugging
- f. Performance and Profiling
- g. Code Optimization
- h. Scientific Libraries: BLAS and LAPACK
- i. Calling C within MATLAB with MEX Files

#### 7. Moving Beyond Sequential Computing

- a. Introduction to Parallel Computing Architectures
- b. Parallel Computing with C and MPI
- c. Parallel Computing with C and OpenMP
- d. Parallel Computing with MATLAB's Parallel Computing Toolbox

## Course Overview

The course will begin with a cursory overview of computer programming and software design. The course will then proceed with an

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Understanding Unix/Linux and its environment is one of the primary goals of the course. The bash shell is the main interface with that environment, providing sophisticated configuration and programming capabilities. Another main goal of this course is to show students the similarities between programming languages and to demonstrate how it is fairly easy to work in any programming language with an understanding of basic programming constructs.

From this point of the semester forward, the development environment will be the Unix/Linux operating system. For Spring 2022, students will use the CSCI OpenStack Cloud Platform to work on Unix/Linux assignments. Before moving forward to the C programming language, the concept of version control will be introduced. The open-source version control system Git will be introduced for this purpose. The course will then proceed with an overview of C as a tool for software design. The course will review basic concepts, syntax, and structure before proceeding forward and discussing advanced concepts such as building programs with Make, and defensive programming and debugging. Various software tools which can dramatically improve a programmer's efficiency as well as his or her understanding of

## Assignments Policy

Assignments will initially be uploaded to the Canvas course website. After version control is introduced, students will employ Git to turn in assignments. Students should make an effort to turn in assignments that are organized with a professional appearance. Proper documentation and commenting should be used to explain programming and software concepts employed. ***Late assignments will have a 10% deduction immediately, and an additional 4% deduction will be applied for each hour the assignment is late. No assignments will be accepted 24 hours after the original due date.*** Students will work individually or in *randomly* assigned groups for each programming assignment. Collaboration is permitted, even between groups. Students may discuss basic concepts related to the programming assignments, but students are **NOT** free to copy another student's assignment (except, of course, if the other student is a group member). ***Students who are caught copying (or providing his or her assignment to another) will receive an "F" for the course and reported to the Dean's office for further punitive action.***

## Quizzes Policy

Quizzes will take place at the beginning of class, and no make-up quizzes will be allowed. The lowest quiz grade will be dropped in computing the average to account for any missed quizzes. --33765 [I]-1 (as)-1. (I

## CU BOULDER POLICIES

### CLASSROOM BEHAVIOR

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail 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, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Conduct & Conflict Resolution policies.

### REQUIREMENTS FOR COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). Please email your instructor if you will be missing class due0.001 Tcbeen i has Csn( par)0.6ne. 7 (el)-1 (37.197

## PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

## HONOR CODE

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, 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. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu; 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as

academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

## SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and the support resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit Don't Ignore It.

## RELIGIOUS HOLIDAYS

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, email your instructor as soon as possible regarding missing class or assignments due to religious holidays. See the campus policy regarding religious observances for full details.