

Hypersonic Vehicle Design Project

ASEN 6519-006, Spring 2022

Last updated: January 13, 2022

Instructor: Dr. Nicholas Campbell, nica3422@colorado.edu

Office hours: Weekly (time TBA) or by appointment, in person or over Zoom

Schedule: 9:10 - 10:25 AM, Wednesday and Friday

In-person location: **AFTER 1/24:** AERO 224L[[Campus Map](#)]

Remote location: Recurring Zoom meeting,

Website: TBD

Course Description

This special topic course is focused on building the understanding, tools and experience needed to design the hypersonic vehicles of the future. Student design teams work on highly integrated projects to generate and optimize the tools and design concepts needed to achieve a vehicle capable of multi-flight success. As a project based course, students will work on a mission-driven vehicle design while experiencing a series of short course-style lectures and guest seminars on a range of engineering topics relevant to designing the next generation of high-speed vehicles.

Lectures will review underlying physics while delving into important advanced concepts such as aerothermochemistry, thermo-structural coupling, and autonomous control. Systems level considerations such as support components, flow control, and thermal management concepts are included with both real world examples and reduced-order methods the design teams can incorporate. Finally, important resources and definitions for system reusability and estimating project/operation costs are covered in the second half of the course.

Course Objectives

This course aims to provide a "hands-on" experience working with the resources and developing the computational tools needed to design a functional and survivable hypersonic vehicle. Students will organize onto design teams to focus on specific aspects of the vehicles design (i.e. aerothermodynamics, structures, GNC). These teams will plan and implement tool development activities as outlined by the design project details and in accordance with the course schedule. Doing so will require inter-team communication on important linkages and integrated systems. Physics based methods and available resources for each team will be covered in various short courses and guest seminars. Students are encouraged to first "pull," one of the suggested methods, "off the shelf," to get a functional physics engine as soon as possible. Then the remaining semester can be spent building on the engine and updating it as needed. At the end of the day, design teams will be allowed to make their own decisions on which methods to use and design conclusions to settle upon. In either case, students must be prepared to discuss these decisions during group discussions and design reviews.

Grading

The table below provides the grading breakdown where quad-charts 1-5, the PDR, and CDR are defined on the course schedule.

Quad-charts @ 1% each	5% total
Preliminary Design Review (PDR)	40% total
- presentation to review panel	25 %
- midterm report	15 %
Critical Design Review (CDR)	55% total
- presentation to review panel	30 %
- final report	25 %
Total	100%

Design reviews will be in the form of a presentation by each design team. Reports will be due 1 week following the design review or as otherwise noted in the schedule. This scheduling is to allow important questions raised in the design review to be addressed in the report as either solutions of proposed steps to find a solution. Presentations and reports will be scored per design team then peer reviews and instructor discretion will be used to provide individual team member grades that adhere to the total as a team average.

Quad-charts will be graded on a scale of 0,1,2 where 0 means the quad-chart was not prepared for the corresponding class period, 1 means the quad-chart was technically prepared but is either a direct copy of the previous quad-chart or it doesn't well represent the known developments of the team, and 2 means the quad-chart is prepared and accurately represents developments that have occurred with the team. Quad-chart grades will be shared by team members indiscriminately. Due to the nature of the course, late quad-charts or design review elements will not be accepted. Email the instructor for accommodations due to illness or other extenuating circumstances.

Reference texts

There is no required textbook. Resources will be either linked or directly provided in lecture notes.

Course Modalities

This course is offered in the following modality:

- **Hybrid: ASEN 6519-006** – students enrolled in this course code should attend class synchronously, either in person or remotely via zoom meeting.

You should be registered in the class code corresponding to the mode you expect to dominantly use. However, all students are permitted to attend the zoom meetings synchronously. Lecture notes or slides will also be posted, when applicable.

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 due to the pandemic, 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.

As of Aug. 13, 2021, CU Boulder has returned to requiring masks in classrooms and laboratories regardless of vaccination status. This requirement is a temporary precaution during the delta surge 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.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, email me and I can provide appropriate accommodations. You do not need to state the nature of your illness, nor is a doctor’s note or other verification required.

Accommodation for Disabilities

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.

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

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder 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 OIEC, university policies, reporting options, and the campus resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when 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.

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, please let me know of the conflict by email and I will work to accommodate your specific situation.

See the campus policy regarding religious observances for full details.