

ASEN 6519 Cooperative Control of Multi-Agent Systems

Spring 2022 Syllabus

Lecture: AERO 114 Tuesday and Thursday, 2:30 – 3:45 pm

Instructor

Prof. Eric Frew

Office: AERO 269 Phone: (303) 735-1285

Email: eric.frew@colorado.edu

Hours: TBD

Text

There is no required text. Readings from the literature will be assigned throughout the course. You will be expected to find copies of the assigned readings on your own.

Prerequisites

This course is intended for advanced graduate students. Students are expected to have a background in linear dynamical systems, which means they should have taken ASEN 5114, ASEN 5014 (or equivalent), or obtain permission from the instructor. Students from all engineering departments are welcome.

Overview

Recent advances in embedded systems and wireless communication have led to the development of complex teams of autonomous vehicles. This course studies the general theoretical and application specific concepts needed to enable cooperative control of multi-vehicle systems.

Theoretical concepts are introduced to prepare students to analyze multiple interacting systems. Graph theory is introduced in order to provide a framework for describing interactions between systems. Many cooperative control problems can be reduced to general graph-theoretic problems. However, moving beyond graph theory motivates discussion of information theory, to describe both wireless communication and cooperative sensing and estimation. Finally, game theory is introduced in order to consider non-cooperative elements such as adversaries, selfish agents, and nature.

Throughout the course, the general theoretical topics will be linked to different problems of cooperative control. Specific problems addressed in this course include cooperative target tracking, multi-vehicle swarming, consensus seeking, controlled mobility in ad-hoc networks, active sensing, robot sensor networks, and hierarchical control architectures for micro-air vehicles.

Course Grading

10%	Homework
25%	Exam 1
25%	Exam 2
40%	Research Paper

Grades for the overall course are set based on the following criteria. **Grades do not correspond to pre-specified ranges of scores.**

A, A-	Demonstrates superior understanding of the material beyond the course requirements, excellent technical work
B+, B	Demonstrates comprehensive understanding of the material, very strong technical work
B-, C+	Demonstrates good understanding of the material, complete technical work
C	Demonstrates adequate understanding of the material to proceed to the next level; sufficient technical work
C-	Does not demonstrate adequate understanding of the material to proceed to the next level
D	Poor technical work
F	Unsatisfactory performance

Homework Policy

Homework will be assigned sporadically throughout the semester. Students are allowed to collaborate on the homework; however, each student must submit her own work.

Research Paper

The main mechanism for disseminating research into the broader scientific community is through conference and journal publications. As researchers, technical writing is one of the most critical, yet overlooked, skills you can obtain. As part of this course, each student will submit a paper on a current cooperative control research topic of their choice. Details of this assignment will be provided during the second week of the course.

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).

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

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.

See the [campus policy regarding religious observances](#) for full details.