

University of Colorado Boulder  
SEN 5044  
Statistical Estimation for Dynamical Systems  
Fall 2022 Course Syllabus

## General Information

**Instructor:** Prof. Nisar Ahmed (Nisar.Ahmed@colorado.edu)

**Instructor Office Hours:** In Person + Zoom, [see Canvas for details](#)

### Course Teaching Assistants:

Kevin Yevak (Kevin.Yevak@colorado.edu),  
Eli Kavitz (Eli.Kavitz@colorado.edu)

**TA Office Hours:** In Person + Zoom, [see Canvas for details](#)

**Lecture Time and Location:** Tues & Thur 11:40 am -12:55 pm, AERO 111. All lectures will be recorded and posted online via course website. Remote/distance learning students may participate live through the Zoom meeting interface (see course website for instructions). For distance students who wish to attend live lectures, this course requires the use of the Zoom conferencing tool. If you use assistive technology to access the course material, please contact the instructor immediately to discuss.

**Course Website:** [canvas.colorado.edu](https://canvas.colorado.edu) (will be used for posting all recorded lectures, homework assignments, quizzes, exams, and announcements/corrections; links to Zoom lecture and office hours, Piazza, and Gradescope are also provided).

**Required Textbook (for readings and assignments, e-book version available):** Dan Simon, 'Optimal State Estimation: Kalman,  $H_\infty$ , and Nonlinear Approaches,' John Wiley and Sons, Inc., 2006, ISBN 9780471708582.

**Note:** [errata for the text can be found here: link](#) (also on Canvas)

**Optional text supplements (not required):** J. Crassidis and J. Junkins, 'Optimal Estimation of Dynamic Systems,' 2nd edition, Chapman and Hall, 2011 – available through C library as an e-book.

R. Stengel, 'Optimal Control and Estimation,' Dover, 1994, 9780486682006 (classic: very good and very cheap).

## Course Details

**Description** This course will introduce students to the theory and methods of state estimation for general linear and nonlinear dynamical systems, with a particular emphasis on aerospace and other engineering applications. Major topics include: review of applied probability and statistics; modeling and optimal state estimation for stochastic dynamical systems; theory and design of Kalman filters for linear systems; linearized and extended Kalman filters for non-linear systems.

## Learning Objectives

lectures can be considered as a ‘mini-course’ to complement the main course material outlined above, and no pre-requisites will be needed to follow them (although they will build on previous course material and on each other). **Viewing of these extra lectures is optional, but strongly recommended for Ph.D. students**, and is highly encouraged for others wishing to dive deeper into estimation theory.

**Grading, Assignments and Exams** Course grades will be determined on the basis of homework (15%), online Canvas quizzes (15%), midterm 1 (20%), midterm 2 (20%), and a final project (30%).

Important things to note:

- Students will be expected to work in groups of 3 for the final project.
- Weekly homework will be assigned, collected, and *partially graded*. Quizzes will be fully graded automatically on Canvas. Solutions for full problem and quiz sets will be posted to Canvas.
- Collaboration on homework is encouraged, but students must turn in their own homework in a timely manner (see policies below). Students may use Piazza for online discussion (this will be loosely monitored by instructor and TAs).
- A series of weekly quizzes will be assigned and administered through Canvas. These will be posted on Friday morning and be due the following Sunday at 11:59 pm (off-nominal posting/due dates will come with special notification, if needed).
- All exams will be take home and open-book/open-note. Students will have exactly one week to complete exams and may not collaborate with each other on exams in any way (Cheating honor code applies).
- Students will **not** require an exam proctor, but will submit all assignments and exams electronically for grading via Gradescope (see requirements on submission quality).
- Students may opt to answer optional ‘Challenge Questions’ for possible extra credit, but extra credit will only be considered if all regular





and students. Students, faculty and staff must upload proof of vaccination and boosters or file for an exemption based on medical, ethical or moral grounds through the MyC Health portal.

The C Boulder campus is currently mask-optional. However, if public health conditions change and masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class,

**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 policy 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 Student Conduct & Conflict Resolution ([honor.colorado.edu](http://honor.colorado.edu)); 303-492-5550). Students found responsible for violating the [Honor Code](#) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to 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** C Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, protected-class discrimination and harassment, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these policies, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about university policies, reporting options, and 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 any issues related to these policies regardless of when or where they occurred to ensure that individu-

students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must notify the instructor at least 2 weeks in advance to schedule make up for completing and turning in exams and other assignments (see Course Details above).

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