The course aims to provide a practical knowledge of Kalman filtering and introduces control theory for stochastic processes. It begins with state-space stochastic models, probability and stochastic process theory review. Then it covers optimal estimation based on the Kalman filter theory and a variety of estimator designs and applications. The course concludes with selected topics in control and estimation. Students will learn through hands-on experience; therefore, the course will be homework intensive.

This course is dedicated to Michael Athans, Professor Emeritus at MIT, a living legend of control engineering and my role model in teaching, who taught me the same subject when I studied in Lisbon.

**Tentative week-by-week course plan:**

- Week 1: Intro to Stochastic Optimal Control
- Week 2: Probability and Random Processes
- Week 3: State-space modeling
- Week 4: White noise propagation through linear systems
- Week 5: Discrete time Kalman Filter
- Week 6: Continuous time Kalman Filter
- Week 7: Extended Kalman Filter
- Week 8: Smoothing
- Week 9: Selected topics in Control
- Week 10: Selected topics in Estimation and Control

**Literature:** My lecture notes will be used as the basis for the course and the exams. To follow the course and for further reference the suggested textbook is: Arthur Gelb, Applied Optimal Estimation, The M.I.T. Press

**Additional readings:** These books are not essential, but recommended as reference literature:

- A.E. Bryson, Y.C. Ho, Applied Optimal Control
- D.P. Bertsekas, S.E. Shreve, Stochastic Optimal Control: The Discrete-Time Case, Athena Scientific

**Prerequisites:** The course relies on a working knowledge of matrix algebra, calculus, differential equations, probability theory. These subjects are not usually covered by a single course and student knowledge may be partial. The
knowledge of MATLAB is expected as well. Therefore, undergraduate student enrollment is conditioned by instructor’s consent.

**Homework** needs to be computer typed using the font size 12pt and printed clearly showing the student’s name. It should be in the form of a full report with all results and figures commented. Students should e-mail me their homework as a .pdf by the deadline; those in my mailbox, slipped under my office door, etc. will not be considered. **No late homework** will be accepted under any circumstances. The two weakest homework scores will be dropped. Also, if you do not have all of the homework done, turn in what you have managed to do by the deadline. All submitted work should be done individually.

**Final grade** will be based on homework, one midterm exam, the final exam and attendance above 70% (homework 25%, midterm 30%, final 40%, attendance 5%). Please bear in mind that your grade will be heavily based on the quality and completeness of problem solutions, and not only on their correctness.

No show on the exam, the exam work not submitted to the instructor or over e-mail by the deadline scores 0. All submitted work should be done individually.

**E-mail:** It is essential that your e-mail message contains a proper salutation. In addressing me, both in person and by e-mail, please use the appropriate title, which is Professor. Always use your ucsc e-mail addresses.

**For DRC students:** If you qualify for classroom accommodations because of a disability, please get an Accommodation Authorization from the Disability Resource Center (DRC) and submit it to me in person outside of class (e.g., during office hours) within the first two weeks of the quarter. Contact DRC at 459-2089 (voice), 459-4806 (TTY), or http://drc.ucsc.edu for more information on the requirements and/or process.

Note: For any questions, I am available in the class and during my office hours.

**Cheating:** Cheating in any form will not be tolerated. Cheating devalues everyone’s grades:

- you shouldn’t tolerate it either
- students who help others cheat are also cheaters.
- students caught cheating will be dropped from the course and receive a failing grade.
- such students will also be reported to their college provost. Please bring your student ID to every exam.

Academic integrity: By enrolling in the university, students are automatically agreeing to abide by policies, including those on academic misconduct.
Academic integrity and scholarship are core values that should guide our conduct and decisions as members of the UCSC community. Plagiarism and cheating contradict these values, and so are very serious academic offenses. Penalties can include a failing grade in an assignment or in the course, or suspension or expulsion from the university. Students are expected to familiarize themselves with and follow citation practices (http://nettrail.ucsc.edu/ethics/index.html) and the university’s Rules of Conduct regarding student conduct and discipline: http://www2.ucsc.edu/judicial/handbook.shtml.

Please note that students may be disciplined for selling, preparing, or distributing course lecture notes for any commercial purpose, whether or not the student himself or herself took the notes.