# Uni ersity of Colorado Boulder
# SEN 5044
# Statistical Estimation for Dynamical Syst ms
# Fall 2017 Cours Sylla us

## General Information

**Instructor:** Prof. Nisar Ahmed (Nisa . hmed@colo ado.edu)

**Course Assistant:** Jacob Denton (Jacob.Denton@colo ado.edu)

**Lecture Time and Location:** Tues & Thur 11-12:15, ECCR 150. All lectures will be recorded and posted online via course D2L website. BBA/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, which is currently not accessible to users using assistive technology. If you use assistive technology to access the course material, please contact your faculty member immediately to discuss.

**Course D2L ebsite:** lea n.colo ado.edu (will be used for posting all recorded lectures, assignments, exams, and announcements/corrections)

**Prof. Ahmed's Office Hours:** ECAE 175, Tues 4-5:30 pm

**CA's Office Hours:** Wed 2-3pm, AES ndergraduate Lounge (ECAE 124)

**Required Textbook (for readings and assignments):**
Dan Simon, 'Optimal State Estimation: alman, $H_1$, and Nonlinear Approaches,' John Wiley and Sons, Inc., 2006, ISBN 9780471708582.
Note: errata for the text can be found online here: link

**Recommended supplements (for your own edification, not required):**
J. Crassidis and J. Junkins, 'Optimal Estimation of Dynamic Systems,' 2nd edition, Chapman and Hall, 2011 – available through C library as downloadable pdf: link
R. Stengel, 'Optimal Control and Estimation,' Dover, 1994, 9780486682006.

## Course Details

**Description** This course will introduce students to the theory and methods of statistical 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 alman filters for linear systems; linearized and extended alman filters for non-linear systems.

**Learning Objectives** Students will gain both a fundamental and practical understanding of estimation algorithms from a general dynamical systems standpoint. This will prepare them to tackle challenging estimation problems that they will eventually encounter in later courses and in their own professional/research pursuits.

In particular, by the end of this course, students will:

1. be well-acquainted with basic theory and engineering usage of proba-a-a-a-329(g2foreory)(ing)-37l:1.

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 in any way.

Online/BBA distance learning students will not require a proctor, but will submit all assignments and exams via dropboxes on the course D2L website.

**tudents are responsible for working out an alternative plan with the instructor for submitting assignments/exams if these cannot be completed in time**.

**Exams must be rescheduled at least 2 weeks prior; homework extensions require at least 4 hour notice. The rescheduling and extension policy will be strictly enforced.**

All students must adhere to the C Honor Code. See below under 'General Policies' for more information regarding expectations for academic integrity, and repercussions for violations thereof.

**Anticipated Course chedule (may vary)**

| Week(s) | Topic | Text Chaps. |
|---|---|---|
| 1 | Intro overview | – |
| 1-3 | Basic linear dynamical systems theory | 1.1-1.7 |
| 3- | Probability and stochastic rocesses | 2.1-2.7 |
| -7 | Least squares estimation | 3.1-3.7 |
| 7-8 | Stochastic linear system analysis | 4.1-4.2 |
| 8-9 | The Kalman filter (KF) | 5.1-5.5 |
| 9-11 | KF tuning, testing, variations, and generalizations | ,7 |
| 11-14 | Nonlinear filters: Bayes filter, Linearized KF, EKF | 13.1,13.2 |
| 14-15 | Continuous-time KF | 8 |

**General Policies (please read carefully)** If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo colorado.edu

required attendance. In this class, students must contact the professor at

tegrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at honor-code.colorado.edu.