

THE UNIVERSITY OF TEXAS AT AUSTIN
The Department of Aerospace Engineering & Engineering Mechanics

ASE 381P.6 – Statistical Estimation Theory
Fall 2018

SYLLABUS

Unique Number 12695

Instructor Dr. Renato Zanetti
Office: WRW 401D, 512-471-5145, renato@utexas.edu
Office Hours: WRW 401D, MF 2:30pm-3:30pm

Class Time: TTh 12:30-14:00

Class Location: BUR 208

Web Page: Course documents will be posted on the course **Canvas** website.

Course Objectives:

This course examines methods of stochastic estimation. At the conclusion of this course, each student should be able to:

- Build a state space model of a dynamical system with available observations
- Understand, explain, and build a batch least-squares-type estimator
- Understand, explain, and build a Kalman filter-type estimator
- Understand, explain, and build a Kalman smoother-type estimator
- Understand, explain, and build a multiple-model type estimator
- Understand, explain, and build a sigma point or particle filter-type estimator

Prerequisites:

The standard math and physics background for college science and engineering students is assumed. This includes knowledge of calculus, differential equations, linear algebra, matrix operations, and probability theory.

Computer:

Solutions to homework problems can be done using a variety of software languages (including MATLAB, Mathematica, Maple, Fortran, C, Java, etc.). Familiarity with MATLAB is desired but not required, although typically all students will use Matlab. In some cases it is required that the student turn in the source code.

Text:

Required: Bar-Shalom and Li, *Estimation with Applications to Tracking and Navigation*

Class Format:

Traditional lectures and discussion will be held during each class period. There will be two midterm exams and a comprehensive final.

Class Website: This class will use Canvas—a Web-based course management system with password protected access at <http://canvas.utexas.edu/> —to distribute course materials, to communicate and collaborate online, to post grades, and for course announcements. You can find support in using Canvas at the ITS Help Desk at 475-9400, Monday through Friday, 8 a.m. to 6 p.m., so plan accordingly.

Grading:

Midterm 1	(Tuesday, October 9, in class)	30%
Midterm 2	(Thursday, November 15, in class)	30%
Comprehensive Final	(Wednesday, December 19, 2-5pm)	40%

Grades are awarded by merit; not by a predetermined distribution. The target range for grades are:

- A: 92-100
- A-: 90-92
- B+: 88-90
- B: 82-88
- B-: 80-82
- C+: 78-80
- C: 72-78
- C-: 70-72
- D: 60-70
- F: 0-60

although the threshold for a particular grade may be shifted downwards (not upwards). Attendance, class participation, and improvement throughout the semester can be (will likely be) considered in borderline grade cases.

Homework Policy: Each homework assignment will be posted on Canvas. The homework does not need to be turned in and it will not be graded. The main objectives of the assignments are to gain computer experience and practice problems that will prepare students for exams. Students are free to work on the homework together and discuss the problems with each other.

Examinations: The exams will assess the students' understanding of the material covered in class and the homework assignments. We will have 2 midterm exams and 1 comprehensive final exam.

Attendance: Regular class attendance is expected. Repeated unexcused absence from class is a justification for a downward adjustment of the student's grade. Medical and professional absences may be excused with proper documentation on a case-by-case basis at the sole discretion of the instructor. In all cases the student should notify the instructor of any planned absences before that class if at all possible. By UT Austin policy you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, you will be given an opportunity to complete the missed work within a reasonable time after the absence.

Important Dates: Refer to <http://registrar.utexas.edu/calendars> for important dates regarding drops, payments, holidays, finals etc.

Class Topics:

The following is a tentative schedule of topics. These can be (will likely be) changed and adjusted as the semester proceeds.

	DATE	TOPIC	NOTES	BOOK	HW
1	Th. 8/30	Introduction, Linear Algebra, Vector Calculus	1.1-1.3, 2.1-2.5	1.1, 1.3	
2	T. 9/4	Probability Basics	3.1-3.6	1.4	
3	Th. 9/6	More Probability	3.6-3.10	1.4-1.5	HW1 “due”
4	T. 9/11	Detection Theory Basics	4.1 – 4.6	1.5	
	Th. 9/13	NO CLASS (CONFERENCE)			
5	T. 9/18	Basic Estimation (LS, ML, MAP, MMSE)	5.1-5.5	2.1-2.4	
6	Th. 9/20	Estimators Performance	5.6-5.9	2.5-2.7	HW2 “due”
7	M. 9/24	The Linear Gaussian Static Case	6.1-6.3	3.1-3.3	
8	T. 9/25	Batch Least Squares	6.4-6.5	3.4	
9	Th. 9/27	Nonlinear Least Squares Estimation	7.1-7.4	3.4.4	HW3 “due”
10	T. 10/2	Linear Dynamic Systems	8.1-8.3	4.1-4.2	
11	Th. 10/4	Linear Dynamic Systems, Cont.	8.4-8.6	4.3-4.4	HW4 “due”
		END MATERIAL EXAM #1			
12	T. 10/9	EXAM #1			
13	Th. 10/11	Random Processes, Batch Estimation			
14	T. 10/16	The Kalman Filter	9.1-9.4	5.1-5.2	
15	Th. 10/18	The Kalman Filter, Cont.	9.5-9.8	5.4-5.6, 9.2	
	10/23-25	NO CLASS (TRAVEL)			HW5 “due”
16	M. 10/29	Information Filter	11.1-11.2	7.2-7.3	
17	T. 10/30	Covariance Factorizations	2.4	7.4	
18	Th. 11/1	Smoothing: RTF and Potter	12.1-12.3	8.6	
19	M. 11/5	Linear MMSE and Orthogonality Principle	1 & 2	10.1-10.2	
20	T. 11/6	LKF, EKF, IEKF	14 & 3	10.3-10.5	HW6 “due”
21	Th. 11/8	Gaussian Filters: EKF, UKF, GSOF	4		
		END MATERIAL EXAM #2			
22	T. 11/13	KF, practical considerations	5		
23	Th. 11/15	EXAM #2			HW7 “due”
24	T. 11/20	Navigation Systems		12	
	Th. 11/22	NO CLASS - THANKSGIVING			
25	T. 11/27	Multiple Model Adaptive Estimation	15.1-15.2	11.6	
26	Th. 11/29	Particle Filters	16.0		
27	T. 12/4	Stochastic Control	10.1-10.3	8.3, 9.4	
28	Th. 12/6	Last Day of Class			HW8 “due”

Academic Integrity: The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

Each student in this course is expected to abide by the University of Texas Honor Code. [See the UT Honor Code above.] Any work submitted by a student in this course for academic credit will be the student's own work. You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else (hard copy or electronic).

Should copying occur (including plagiarism/copying from internet source or any other source), both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Code can also be extended to include failure of the course and University disciplinary action. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

Course Evaluation: The Measurement and Evaluation Center forms for the College of Engineering will be used during the last week of class to evaluate the course and the instructor. I will not have access to these evaluations until about one month after the end of the semester.

Special Notes:

Students with Disabilities: The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact me or the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.