EE 563: Estimation Theory—Syllabus—Fall 2008

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Course Objectives and Description: In this course you will learn famous and frequently used parameter and state estimation techniques and algorithms that are widely used in many fields. The course will cover: least squares, best-linear unbiased estimation (BLUE), maximum-likelihood, mean-squared, maximum a posteriori, mean-squared state-prediction, -(Kalman) filtering, and -smoothing, extended Kalman filtering, and Unscented Kalman filtering. The course will also cover an overview of higher-order statistics. It not only will present derivations and performance analyses of the major estimation algorithms that are in use today, as well as their applications, but will also explain how and when many of the algorithms are interrelated.

Prerequisites: A graduate course in random processes in engineering (EE 562a).


Additional Readings:
Course Requirements

Discussion Section: A formal discussion section has been added to this course. It will cover topics I do not have time to cover in class, as well as homework solutions. It will be held on Wednesday, 8:30 – 9:20am in DEN, OHE 132.

Homework: There will be weekly homework assignments. Homework will be collected and checked, but will not be graded. Homework solutions will be examined by the grader and a check mark will be indicated for each problem that is completely solved. An excellent record of homework completions can alter your grade in a positive direction (e.g., B to B+, A- to A, etc.). A poor record of homework completions will not directly affect your grade. To receive credit, all homework must be received by 5pm on the day that the homework is due. Late homework will receive no credit.

Projects: There will be a project.

Examinations: One midterm and one final examination.

Grade: Based on the examinations and project in proportions given under “General Information.”
Detailed Course Outline (Note: "Lessons" are keyed into the text)

AUG.  26 Introduction, Coverage and Philosophy/ The Linear Model (Lessons 1 & 2)
     28 Least-Squares Estimation: Batch Processing (Lesson 3)
SEPT.  2 Least-Squares Estimation: Recursive Processing (Lesson 5)
      4 Small Sample Properties of Estimators (Lesson 6)
      9 Large Sample Properties of Estimators (Lesson 7)
    11 Elements of Multivariate Gaussian Random Variables (Lesson 12)
    16 Mean-Squared Estimation of Random Parameters (Lesson 13)
    18 Elements of Discrete-Time Gauss-Markov Random Processes (Lesson 15)
   23 State Estimation: Prediction (Lesson 16)
   25 State Estimation: Filtering (The Kalman Filter) (Lesson 17)
   30 Linearization and Discretization of Nonlinear Systems (Lesson 23)
OCT.   2 Iterated Least Squares and Extended Kalman Filtering (Lesson 24)
     7 Unscented Kalman Filtering–1
     9 Unscented Kalman Filtering–2
    14 Singular Value Decomposition and Computation of LSE's (Lesson 4)
    16 Properties of Least-Squares Estimators (Lesson 8)
    21 Best Linear Unbiased Estimation (Lesson 9)
   23 MIDTERM «Covering all material through October 9»
   28 Likelihood (Lesson 10)
   30 Maximum-Likelihood Estimation (Lesson 11)
NOV.   4 Maximum A Posteriori Estimation of Random Parameters (Lesson 14)
     6 State Estimation: Filtering Examples (Lesson 18)
    11 State Estimation: Steady-State Kalman Filter and its Relationship to a Digital
        Wiener Filter (Lesson 19)
    13 State Estimation: Smoothing (Lesson 20)
    18 State Estimation: Smoothing (General Results) (Lesson 21)
   20 State Estimation for the Not-So-Basic State-Variable Model (Lesson 22)
   25 Maximum Likelihood State and Parameter Estimation (Lesson 25)
DEC.   2 Higher-Order Statistics: an Overview (Lesson B)
    4 Higher-Order Statistics: an Overview (Lesson C)
DEC.   11 FINAL EXAMINATION (2pm-4pm) «Emphasizing Material not covered in the
       Midterm; but, covering the entire semester, excluding HOS»