Utah State University
ECE 7030
Detection and Estimation Theory
Syllabus – Fall 2016

Course title: Detection and Estimation Theory

Instructor: Mohammad Shekaramiz

Class Number: EL 109, ECE Dept.

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Class Time: MWF 10:30 – 11:20

Office Hours: MWF 14:00 – 16:00

Help Sessions: Fridays 16:00 – 17:00

Prerequisite: Preferably, ECE 6030 and ECE 6010

Textbook: *Mathematical Methods and Algorithms for Signal Processing*, by Moon and Stirling, (Prentice-Hall 2000)

Optional textbook 1: *Machine Learning*, Kevin P. Murphy, (MIT Press 2012)

Optional textbook 2: *Pattern Recognition and Machine Learning*, Christopher M. Bishop, (Springer 2009)

Homework: We will have assignments approximately every week

Late Policy: Absolutely no late work will be accepted without prior consultation with the instructor. Work that is not turned in on time without approval will not be scored.

Cheating: Do not cheat! The instructor reserves the right to fail any student who can be justifiably accused of cheating. Work with evidence of cheating will be given a score of 0.

Programming: We will have several programming assignments to help you better understand the concepts and their applications.

Exams: We will have a midterm and a final exam. All exams will be take-home.

Course Summary: Detection and estimation theory address the problem of making decisions and measuring parameters in the presence of noise. Probability theory forms an important set of tools in this area. We will address Neyman-Peason detection, Bayes detection, and estimation theory including the Kalman filter and particle filters. We will also examine the expectation-maximization (EM) algorithm and hidden Markov models. As time permits, we will also examine Gibbs sampling, sampling theory, and statistical learning

Course Fees: Like most courses in the ECE department, course fees are assessed for this course. These fees are used to cover general computer usage in the department and for grader support.

Final Exam: Time to be determined.

Disabilities: In cooperation with the Disability Resource Center, reasonable accomodation will be provided for qualified students with disabilities. Please meet with the instructor during the first week of class to make arrangements. Alternate format print materials (large print, audio, diskette or Braille) willl be available through the Disability Resource Center.

Course Outline:
The following topics are scheduled, and will be presented as time permits.

1. Introduction and Overview. Probability review and notation.
2. Estimation theory
3. ML principle and ML estimation
4. Biased and unbiased estimators
5. Minimum variance unbiased estimator (MVUE); Best linear unbiased estimator (BLUE); Cramer-Rao (CR) Bounds
6. EM algorithm; Hidden Markov models and related models
7. Bayes estimation
8. Kalman filtering; particle filtering, unscented Kalman filters
9. Gaussian process models
10. Detection theory
11. Neyman-Pearson detection
12. Bayes detection. MAP
13. Some applications

In addition, there are a variety of topics that we will cover as time and interest allows such as

- Sparse Bayes
- Markov Chain Monte Carlo techniques. Gibbs sampling
- Naive Bayes detection
- Sequential Bayes; conjugate priors
- Factor graphs
- Some important topics in machine learning

Grading:
The scores will be weighted as follows:

- Homework 100
- Programming 100
- Midterm 100
- Final 100
- Total 400

Grades are assigned as:
$A \quad > 93\%$
$A^- > 90\%$
$B^+ > 87\%$
$B \quad > 84\%$
$B^- > 80\%$
$C^+ > 77\%$
$C \quad > 74\%$
$C^- > 70\%$
$D^+ > 67\%$
$D \quad > 64\%$
$D^- > 60\%$
$F \quad < 60\%$