ELEG 5633 Detection and Estimation
Course Syllabus

General Information: Instructor: Jingxian Wu | Office: Bell 3181
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Office Hour: Tu. Th. 11:00-12:00

Textbooks:
- Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory", Prentice Hall, 1993
- Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume 2: Detection Theory", Prentice Hall, 1998
- Software: Matlab with Signal Processing Toolbox

Reference:
- Harry L. Van Trees, "Detection, Estimation, and Modulation Theory", Part I, II, III, IV
- H. Vincent Poor, "Introduction to Signal Detection and Estimation"
- Louis L. Scharf and Cedric Demeure, "Statistical Signal Processing: Detection, Estimation, and Time Series Analysis"

Prerequisites: Signal and System, Probability and Random Process
- Familiar with Matlab Programming
- Knowledge of linear time invariant system, Fourier series and transform, Laplace transform, time domain and frequency domain representation of signals, power spectrum density, and energy spectrum density of deterministic signals
- Knowledge of discrete and continuous random variable, probability mass function, probability density function, moments of random variables, moment generating function
- Knowledge of random process, wide sense stationary random process, auto-correlation function, power spectrum density of random signals

Learning Objectives: To understand the theory and algorithms of detection and estimation. Detection and classification theory and algorithms, including hypothesis testing, signal detection in the presence of noise. Estimation theory, including maximum likelihood estimation, Bayesian signal processing, etc.

Grading:
- Test 1 30%
- Test 2 30%
- Homework and Projects 40%

- A: $90 \leq \text{grade} \leq 100$
- B: $80 \leq \text{grade} < 90$
- C: $70 \leq \text{grade} < 80$
- D: $60 \leq \text{grade} < 70$
- F: $0 \leq \text{grade} < 60$

- Due dates for homework and lab report will be strictly enforced. Late submission within one week after due date will receive a 20% grade deduction, and no credit if submitted after one week from the due date.
- If for some legitimate reason (sickness, death in the family, etc.), you cannot take an **exam** on the scheduled day, you must notify the instructor **prior** to the exam.

Online Resources:

- Course materials (Slides, Homework, Projects, References, etc) can be found at https://wuj.hosted.uark.edu/teaching/eleg5633/eleg5633.html
- Please check course website **at least once per week** for updates.

Academic Honesty:

Each University of Arkansas student is required to be familiar with and abide by the University's 'Academic Integrity Policy' which may be found at http://provost.uark.edu/
Students with questions about how these policies apply to a particular course or assignment should immediately contact their instructor.

Course Outline:

1. Introduction
   - Review of Probability and Statistics
   - Review of Linear Algebra
   - Parametric Models and Sufficient Statistics

2. Detection and Classification
   - Hypothesis Testing (Simple Binary, Composite, Multiple)
   - Detection of Signals in Noise, Energy and Subspace Detection
   - Asymptotics, Kullback-Leibler Divergence

3. Estimation Theory
   - Bayesian Estimation
   - MMSE
   - Maximum Likelihood Estimation
   - Minimum variance unbiased estimation
   - Least squares estimation

4. Advanced Topics
   - Wiener and Kalman Filtering,
   - Inverse Problems, Sparsity, Graphical Models

The above schedule is subject to change without prior notice.