ECE3077

Introduction to Probability and Statistics for ECE (3-0-3)

Prerequisites: ECE 2020/2030 and ECE 2040 and MATH 2401/2411/24X1 [all courses min C]

Corequisites: None

Catalog Description: Introduction to probability, random variables, distributions, estimation, confidence intervals, linear regression and other tools for describing and managing uncertainty in electrical and computer engineering.

Textbook(s)


Topical Outline

1. Introduction to Probability
   a. sets, axioms of probability
   b. basic combinatorics and counting
   c. independence, conditional probability
   d. inference using Bayes' rule
   e. Applications to ECE: radar detection, transmission of digital information, network connectivity and reliability

2. Random Variables
   a. densities and distribution functions (discrete and continuous)
   b. expectation and moments
   c. the moment generating function
   d. example distributions (Bernoulli, Binomial, Geometric, Poisson, Gaussian, Exponential, etc)
   e. Applications to ECE: noise in electronic circuits, queueing in networks, cache in computers, bit errors in communications, modeling failure times, probability models for speech and optical character recognition, modeling optical communication systems

3. Multiple Random Variables
   a. joint densities and distributions
b. conditional densities and conditional expectation

c. independence, correlation, and covariance

d. multidimensional Gaussians, covariance matrices

e. joint functions of random variables

f. sums of random variables

g. Applications to ECE: modeling manufacturing variation, modeling dependencies in natural language, signal detection, signals in additive and multiplicative noise

4. Limit Theorems

a. the central limit theorem

b. law of large numbers

c. Applications to ECE: analysis and modeling of photodetectors, polling, modeling noise in instrumentation

5. Random Sequences

a. the Bernoulli process

b. the Poisson process

c. Markov chains and random walks

d. Applications to ECE: task scheduling, Markov models of language for speech processing, queueing in network routers

6. Basic Statistics

a. sample mean and variance

b. confidence intervals

c. hypothesis testing

d. curve-fitting and regression

e. parameter estimation

f. Applications to ECE: detection in digital communications, direction-of-arrival estimation, target tracking
7. Further Topics of Probability and Statistics in ECE
   a. generating random numbers
   b. Monte Carlo simulations
   c. entropy and information
   d. average case analysis of algorithms