ECE 302 Probabilistic Methods in EE

Course Description

ECE 302 Probabilistic Methods in Electrical Engineering (3 cr.) Class: 3. Lab: 0. Rec: 0. P/C: ECE 301. An introductory treatment of probability theory, including distribution and density functions, moments, and random variables. Applications of normal and exponential distributions. Estimation of means and variances. Hypothesis testing and linear regression. Introduction to random processes, correlation functions, spectral density functions, and response of linear systems to random inputs.

Prerequisites: ECE 301 or equivalent must be taken prior to or concurrently with ECE 302.

Course Information

- Website: `http://www.engr.iupui.edu/~skoskie/ECE302/ECE302_s15.html`
- Lecture: TR 4:30–5:45 am in BS-3015
- Instructor Sarah Koskie, `skoskie@iupui.edu`
- Office Hours: tbd, or by appointment, in SL-164F
- Required Text: Yates, Roy D. and David J. Goodman, *Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers*, 3nd edition, Wiley, 2014. ISBN: 978-1-118-32456-1.
- Course requirements / Exams / Grading
  - Homework assignments, which may involve simple Matlab programming 15%
  - Two midterm exams each 25%
  - One final exam 35%

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Homework Assignments

Homework assignments will be announced in class and posted on the web. Each homework is due in class on the assigned date, which may be announced in class and will be posted to the course website. Homework may be submitted as pdf files by email before class. Please do not send obscure formats, zipped files, or extremely long files.

- Late homework will NOT be accepted.
- Work submitted should be the student's own.
- All necessary steps towards obtaining the solution, as well as any MATLAB code, must be included in the writeup for full credit.

There will be approximately ten homework assignments during the course of the semester. Each student's lowest two scores will be dropped. Students should keep returned homework as results of some problems may be used in later homework assignments.

Students are allowed, even encouraged, to work on the homework in small groups, but each student must hand in an individual set of answers, which must be their own work. Students may discuss the problems but should not work jointly on them. Discussions should be noted, e.g. "John and I compared approaches to this problem because we found our results surprising; but after considering the alternatives decided that we both had the right approach." or "I kept getting a negative number for an answer and Jane suggested I check whether I forgot to whiten the data, which I had. I fixed this and got the answer indicated." or "John and Jane and I couldn't see how to approach this and Jean suggested . . . which yielded a successful approach." Each student must write their own Matlab code where needed.

Exams

Cheating on any exam will result in a grade of F in the course. Don't do it. It's better to just get a low grade on one exam if you find yourself not adequately prepared. That still leaves you a chance of passing the course.

Course Outcomes

Upon successful completion of the course, students should be able to:

- Solve simple probability problems with electrical and computer engineering applications using the basic axioms of probability.
- Describe the fundamental properties of probability density functions with applications to single and multivariate random variables.
- Describe the functional characteristics of probability density functions frequently encountered in electrical and computer engineering such as the Binomial, Uniform, Gaussian and Poisson.
- Determine the first through fourth moments of any probability density function using the moment generating function.
- Calculate confidence intervals and levels of statistical significance using fundamental measures of expectation and variance for a given numerical data set.
- Discern between random variables and random processes for given mathematical functions and numerical data sets.
- Determine the power spectral density of a random process for given mathematical functions and numerical data sets.
- Determine whether a random process is ergodic or nonergodic and demonstrate an ability to quantify the level of correlation between sets of random processes for given mathematical functions and numerical data sets.
- Model complex families of signals by means of random processes.
- Determine the random process model for the output of a linear system when the system and input random process models are known.

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Topics to be Covered

All time estimates below are very rough estimates.

1. Introduction, applications of probability, relative-frequency approach, review of set theory (approx. 2 classes)
2. Axiomatic approach, conditional probability, independence (approx. 2 classes)
3. Bernoulli trials, random variables and distribution functions, probability density functions (approx. 2 classes)
4. Mean values and moments, Gaussian random variables, density functions related to Gaussian (approx. 2 classes)
5. Other density functions, conditional density functions, applications (approx. 2 classes)
6. Applications, test, joint distributions (approx. 2 classes)
7. Conditional probability, independence, covariance, sums of random variables (approx. 2 classes)
8. Random process definitions, examples of random processes, measurement of random processes (approx. 2 classes)
9. Correlation functions, properties of correlation functions, measurement of correlation functions (approx. 2 classes)
10. Cross-correlation functions, applications, test (approx. 2 classes)
11. Spectral density, properties of spectral density, mean-square values from spectral density (approx. 2 classes)
12. Sampling and estimation theory, point and interval estimation (approx. 2 classes)
13. Sampling distributions, estimation of means and variances (approx. 2 classes)
14. Hypothesis testing, goodness-of-fit test (approx. 2 classes)
15. Linear regression, correlation (approx. 2 classes)