Syllabus

**Probability and Random Processes for Engineers**

(aka **Random Signals and Noise**)

Course description: Random events, random variables, and random processes, with emphasis on probabilistic treatment of signals and noise. Specific topics include: sample spaces, probability, distributions, independence, moments, covariance, time/ensemble averages, stationarity, common processes, correlation and spectral functions.

Prerequisites: Multivariate calculus, continuous-time signals and systems.

Learning outcomes: By the end of the course, students should be able to

1. demonstrate an understanding, both conceptually and mathematically, of probability, random events, random variables, and random processes;
2. calculate probabilities, conditional probabilities, expected values, etc., for random events, random variables, and random processes by utilizing a variety of mathematical tools and methods; and
3. define and use various kinds of random variables and processes commonly encountered in electrical engineering.

Course content: This content is designed for a 10-week, 4-unit course (about 40 class meetings).

|  |  |  |
| --- | --- | --- |
| Topic | Book sections | No. lectures |
| **Probability rules**  Sample space, event, probability axioms, equally likely events, complement rule, addition rule | 1.1-1.2 | 2 |
| **Counting methods**  Permutations, combinations | 1.3 | 2 |
| **Conditional probability and independence**  Conditional probability, tree diagrams, multiplication rule, independent events, law of total probability, Bayes’ rule | 1.4-1.5 | 3 |
| **Discrete random variables**  Probability mass function, expected value, variance, standard deviation, binomial, Poisson distributions | 2.1-2.5 | 5 |
| **Continuous random variables**  Probability density function, cumulative distribution functions, expected value, variance, standard deviation, uniform, normal, exponential distributions | 3.1-3.4 | 5 |
| **Joint distributions and their applications**  Joint distributions (discrete and continuous), covariance and correlation (discrete and continuous), mean and standard deviation of linear combinations (brief), bivariate Gaussian distribution, Central Limit Theorem | 4.1-4.3, 4.5, 4.7 | 6 |
| **Random processes**  **(emphasis on continuous-time processes)**  Concept and classification of random processes, temporal v. ensemble behavior, mean, autocorrelation, and autocovariance functions, wide-sense stationary processes | 7.1-7.3 | 7 |
| **Poisson and Gaussian processes**  Poisson counting process, Poisson telegraph, stationary Gaussian processes, Brownian motion, Gaussian white noise | 7.5-7.6 | 3 |
| **Introduction to signal processing**  Power spectral density and its properties, Wiener-Khinchin formula, white noise processes, LTI systems, ideal filters | 8.1-8.2 | 4 |
|  |  |  |