**30231002 Probability and Stochastic Processes (1)**

Lecturer: Yuan Shen

Time: Tuesday, 9:50-11:25

Location: 6A216 (Online Tencent Meeting ID: 35997643674)

Text Book:

* D.P. Bertsakas and J.N. Tsitsiklis. **Introduction to Probability**. *Athena Scientific*, 2nd edition, 2008.

Reference books:

* Hao Zhang. **Probability Theory**. *Higher Education Press*, 2018.
* G.R. Grimmett and D.R. Stirzaker. **Probability and Random Processes**. *Oxford University Press*, 3rd edition, 2001.
* S.M. Ross. **A First Course in Probability**. *Pearson*, 8th edition, 2010.

Prerequisite: Calculus, linear algebra

Grades: Homework 30% + Midterm 30% + Final 40% (+ Bonus 5%)

Course Introduction:

This course will introduce students to the modelling, quantification, and analysis of uncertainty. Topics covered include: formulation and solution in sample space, random variables, transform techniques, simple stochastic processes and their probability distributions, and limit theorems.

Syllabus

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| **Week** | **Topic** | **Content** | **Chapter** |
| 1 | Introduction | Course information | Introduction |
| History of probability theory |
| Review of probability in high school |
| Probability space (I) | Probability space | Sample space and probability |
| Sample space |
| -algebra |
| 2 | Probability space (II) and conditioning (I) | Probability measures |
| Conditional probability |
| 3 | Conditioning (II) and independence | Multiplication rule, Total probability theorem, and Bayes’ rule |
| Independence |
| 4 | Discrete random variables | Random variables | Discrete random variables |
| Expectation and variance |
| 5 | Multiple discrete random variables | Conditional probability mass function and expectation |
|  |
| Multiple discrete random variables |
| Independence of random variables |
| 6 | Continuous random variables | Continuous random variables | General random variables |
| Cumulative distribution function |
| Normal and exponential random variables |
| 7 | Multiple continuous random variables | Multiple continuous random variables |
| Conditional probability density function, conditional expectation, and independence of continuous random variables |
| The continuous Bayes’ rule |
| 8 | Derived distributions and entropy | Derived distributions | Further topics on random variables |
| Entropy |
| Maximum entropy distributions |
| 9 | **[In-class mid-term examination]** | |
| 10 | Convolution, covariance, correlation, and conditional expectation | Convolution |
| Covariance and correlation |
| Conditional expectation |
| 11 | **(No class)** | |
| 12 | Transforms and sum of a random number of random variables | Transforms |
| Sum of independent random variables |
| Sum of a random number of random variables |
| 13 | Weak law of large numbers | Probabilistic inequalities | Limit theorems |
| Weak law of large numbers |
| Various kinds of convergence |
| 14 | Central limit theorem | Central limit theorem |
| Strong law of large numbers |
| 15 | Elementary stochastic processes | Bernoulli process | Stochastic processes |
| Poisson process |
| 16 | Borel-Cantelli lemma | Limit of set sequence | Limit theorems |
| Borel-Cantelli lemma |
| Course review | Course review | Review |