



## Probability and Random Processes

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### Contact Information

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### Course Objectives

This module aims at providing a basic knowledge of probability theory and random processes suitable for students in engineering, Computer Science, and Mathematics. The module provides students with basic skills needed for formulating real-world problems dealing with randomness and probability in mathematical language, and methods for applying a toolkit to solve these problems. Mathematical rigor is used where appropriate. A more advanced treatment of the subject is deferred to the third-year module Stochastic Processes.

The lecture comprises the following topics

- Brief review of number systems, elementary functions, and their graphs
- Outcomes, Events & Sample Space. Combinatorial probability.
- Conditional probability and Bayes' formula.
- Binomials & Poisson-Approximation
- Random Variables, distribution and density functions.
- Independence of random variables.
- Conditional Distributions and Densities.
- Transformation of random variables.
- Joint distribution of random variables and their transformations.
- Expected Values & Moments, Covariance.

- High dimensional probability: Chebyshev and Chernoff bounds.
- Moment Generating Functions & Characteristic Functions.
- The Central limit theorem.
- Random Vectors & Moments, Covariance matrix, Decorrelation.
- Multivariate normal distribution.
- Markov chains, stationary distributions.

## Homework

There will be 8 homework for this course. You can find Problem sets on the course page. The grade will be calculated based on the top 6 grades. Late homework will not be accepted. You are encouraged to work in groups, but each class participants has to write the homework by themselves. You are encouraged to use books or internet resources, but do not search for the problems appearing on the assignments.

## Final exam

The final exam is based on all the topics discussed in class during this semester. The exam period is in the range 90-120 minutes. The exam is structure as follows:

Question type	Points
Conceptual multiple choice and true-false questions	30
Computational multiple choice and true-false questions	30
<i>Seen</i> problems (similar to homework problems)	20
<i>Unseen</i> problems	20

## Grade Policies

The grade in this class is fully based on the performance in the final exam. The bonus points collected by doing homework and Moodle quizzes can raise your grade by up to 0.66 points. The bonus points will only be added if the final grade is at least 45.

## The Code Of Academic Integrity

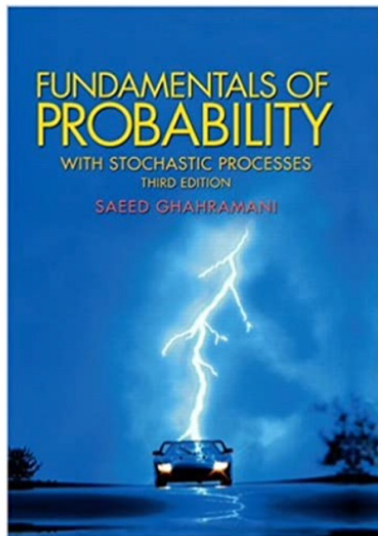
Rules and regulations found in The Code Of Academic Integrity apply to this class.

## Syllabus Change Policy

This syllabus is only a guide for the course and is subject to change with advanced notice.

This syllabus is only intended as guidance for class participants. In particular, it is subject to modification in case needs arise.

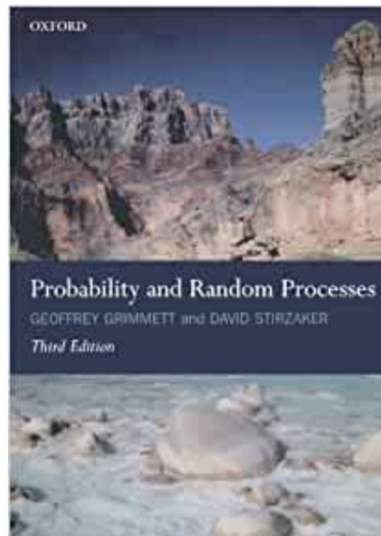
## Textbooks



Fundamentals of probability.

S. Ghahramani

Large set of exercises

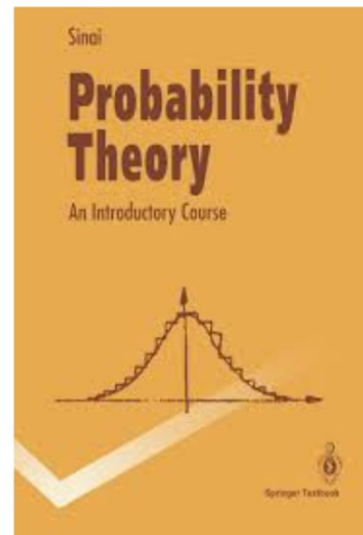


Probability and random processes.

G. Grimmett and D. Stirzaker.

Large set of exercises

Additional topics



Probability theory

Ya. Sinai

More advanced

Additional topics

## Course schedule

<a href="#">Fri, 2. Sep. 2022</a>	Basica ideas of probability		
<a href="#">Wed, 7. Sep. 2022</a>	Pascal's equiprobable model, sample space		
<a href="#">Fri, 9. Sep. 2022</a>	Counting, Birthday paradox		
<a href="#">Wed, 14. Sep. 2022</a>	Inclusion and exclusion	PS 1 Posted	
<a href="#">Fri, 16. Sep. 2022</a>	Geometric probability		
<a href="#">Wed, 21. Sep. 2022</a>	Conditional probability, independence		
<a href="#">Fri, 23. Sep. 2022</a>	Bayes' formula	PS 2 posted	PS 1 due
<a href="#">Wed, 28. Sep. 2022</a>	Random variables, discrete random variables, distribution		
<a href="#">Fri, 30. Sep. 2022</a>	Properties of distribution function, continuous random variables		
<a href="#">Wed, 5. Oct. 2022</a>	Research day; class does not meet	PS 3 posted	PS 2 due
<a href="#">Fri, 7. Oct. 2022</a>	Important classes of random variables		
<a href="#">Wed, 12. Oct. 2022</a>	Practice Exam		
<a href="#">Fri, 14. Oct. 2022</a>	Discussion of Practice exam		
<a href="#">Wed, 19. Oct. 2022</a>	Expectation and variance for discrete random variables		
<a href="#">Fri, 21. Oct. 2022</a>	Properties of expectation, applications	PS4 posted	PS3 due
<a href="#">Wed, 26. Oct. 2022</a>	Expectation and variance for continuous random variables		
<a href="#">Fri, 28. Oct. 2022</a>	Joint distribution, marginals, independence of random variables		
<a href="#">Wed, 2. Nov. 2022</a>	Joint density for continuous random variables	PS 5 posted	PS4 due
<a href="#">Fri, 4. Nov. 2022</a>	Conditional distribution and conditional expectation		
<a href="#">Wed, 9. Nov. 2022</a>	Conditional densituy function		
<a href="#">Fri, 11. Nov. 2022</a>	Sums of random variables, random walks		
<a href="#">Wed, 16. Nov. 2022</a>	The Chebyshe, Markov and Chernoff inequalities	PS 6 posted	PS5 due
<a href="#">Fri, 18. Nov. 2022</a>	The weak law of large numbers		
<a href="#">Wed, 23. Nov. 2022</a>	The central limit theorem and applications		
<a href="#">Fri, 25. Nov. 2022</a>	Markov property, Markov chains, examples	PS7 posted	PS6 due
<a href="#">Wed, 30. Nov. 2022</a>	Computation with Markov chains, long term behavior		
<a href="#">Fri, 2. Dec. 2022</a>	Stationary distribution for Markov chains	PS 8 posted	
<a href="#">Wed, 7. Dec. 2022</a>	Review		PS7 due