## GENERAL INFORMATION

**Course Title: Applied Probability, MATH 3320**

Field: Mathematics

Credit Weight: 3

Semester and Year: Winter 2025

Pre-requisites: MATH 2230 Honours Linear Algebra; MATH 2423 Probability

**Course Description**

This course presents a broad range of advanced topics and applications of probability theory, useful in the areas such as communications, signal processing, networks, machine learning, econometrics and mathematical finance. Special attention is given to stochastic processes, including random variables, limit theorems, random processes, Poisson process, discrete-time Markov chains, semi-Markov processes and continuous-time Markov chains and Hidden Markov models.

**Learning Objectives**

By the end of this course, students will be able to do the following:

- Have a general knowledge of the theory of stochastic processes, in particular Markov processes.
- Perform calculations of probabilities using the properties of the Poisson process in one and several dimensions.
- Construct a model graph for a Markov chain or process describing a given system, and use the model for studying the system.
- Apply techniques of stochastic processes to modelling real-world problems.

**Required Text/Readings**:

***Probability, Random Processes, and Statistical Analysis: Applications to Communications, Signal Processing, Queueing Theory and Mathematical Finance,*** Hisashi Kobayashi, Brian L. Mark, William Turin, 2012.

**Accessibility Services (Accommodations)**

Students with documented academic, medical, emotional, and/or physical disabilities, who require accommodation, must provide current documentation attesting to the specific nature of their disability to Academic Accommodations Coordinator and Associate Registrar. Students are responsible for submitting the appropriate documents and forms in a timely manner. A meeting to review documentation and discuss accommodations is strongly recommended.

**Academic Honesty**

Please read the relevant section of the College's policy on academic honesty in the student Code of Conduct. Briefly academic dishonesty includes: cheating, fabrication, and plagiarism. Please ask me if you have any questions about whether something constitutes academic dishonesty. Academic dishonesty will not be tolerated and will result in failure of the course. Institutional penalties may also apply.

**Attendance Policy & Class Participation**

You are expected to complete all assignments and exams on time, attend class regularly, and come to class prepared to participate actively. Please have readily available the assigned readings and texts. They will be a valuable resource for our discussions and will assist you in following lectures.

**Evaluation of Performance**

Final grades will be determined as follow:

| | |
|---|---|
| 5 Homework | 30% |
| 3 Quizzes | 30% |
| Midterm Test | 15% |
| Final Exam | 25% |
| Total | 100% |

Grades will be assigned as follows:

| Grade | | Grade | |
|---|---|---|---|
| A | (93- 100%) | C | (73-76%) |
| A- | (90-92%) | C- | (70-72%) |
| B+ | (87-89%) | D+ | (67-69%) |
| B | (83-86%) | D | (64-66%) |
| B- | (80-82%) | D- | (60-63%) |
| C+ | (77-79%) | F | (<60%) |

**Content**

| **Module Topics** | **Materials** | **Tasks** |
|---|---|---|
| Course introduction<br>Probability<br>Discrete and continuous random variables<br>Functions of random variables and their distribution | Chapter 1-6 | Homework 1<br>Quiz 1 |
| Generating functions and Laplace transform<br>Inequalities, bounds, and large deviation approximation<br>Limit theorems | Chapter 9-11 | Homework 2<br>Quiz 2 |
| Random processes<br>Spectral representation of random processes and time series<br>Poisson process, birth-death process, and renewal process<br>Discrete-time Markov chains<br>Semi-Markov processes and continuous-time Markov chains<br>Random walk, Brownian motion, and diffusion | Chapter 12-17 | Homework 3<br>Midterm Test |

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|---|---|---|
| Estimation and decision theory<br>Estimation algorithms | Chapter 18-19 | Homework 4<br>Quiz 3 |
| Hidden Markov models and applications<br>Probabilistic models in machine learning<br>Filtering and prediction of random processes<br>Queuing and loss model | Chapter 20-23 | Homework 5<br>Final Exam |

This syllabus is subject to change. Keep aware of the changes that might occur. There will be announcement if that happens.