Introduction to Stochastic Differential Equations (IMT 3800)

Spring semester, 2021

Instructor:
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Class web page:
https://cursos.canvas.uc.cl/courses/36152

Class meeting times:
Mon & Wed 10:00 am – 11:20 am
(Zoom link available on Canvas)

Virtual office hours via Zoom:
Mon & Wed 2:00 pm – 3:00 pm
(or by appointment)

Please note: Announcements and other information about the class will be posted regularly on the Canvas web page.

Course description:

This semester, the focus of IMT 3800 will be on the theory and applications of stochastic differential equations. Topics covered will include Brownian motion and white noise, stochastic integration, the Itô calculus, existence and uniqueness of solutions to stochastic differential equations, and the Feynman-Kac formula. More advanced topics, such as Lévy processes, stochastic control theory, and inference for diffusion processes may be addressed depending on the interests of the class and time restrictions.

Learning outcomes:

Stochastic differential equations have diverse applications in physics (Feynman-Kac formula), engineering (filtering and control theory), the financial markets (stock price modeling), and non-parametric statistics, among others. Upon successful completion of this course, students will be able to demonstrate the following competencies: (i) a working understanding of stochastic differential equations and the theory of Itô calculus, and (ii) the ability to further develop current applications of stochastic differential equations in engineering and mathematics.

Course textbook:

- An Introduction to Stochastic Differential Equations by Lawrence C. Evans. American Mathematical Society, 2013.

Grading policy:

The final grade will be based on homework assignments and a final take-home exam.

Homework assignments	**60%**
Final exam	**40%**

Homework assignments:

Homework problems will be handed out on a regular basis. Discussion of homework assignments with other students is encouraged, but what is handed in should be your own work.

Course content:

- Elements of probability theory
  - Probability measures
  - Lebesgue integration
  - Classical limit theorems
  - Conditional expectations
  - Martingales and semi-martingales
- Brownian motion and white noise
  - Definitions and elementary properties
  - Construction of Brownian motion
  - Sample path properties
  - Markov property
  - Generalized processes and Schwartz distributions
  - White noise
- Stochastic integrals
  - Paley-Wiener integral
  - Itô integral and the Itô isometry
  - Itô calculus
- Stochastic differential equations
  - Existence and uniqueness of solutions
  - Properties of solutions
  - Feynman-Kac formula and connections with PDEs
- Applications
  - Filtering and stochastic control theory
  - Inference for stochastic differential equations
  - Non-parametric estimation