ACT460/STA2502 Stochastic Methods for Actuarial Science

Fall 2018

Day/Time: Tue 2pm-5pm **Location:** Sidney Smith 2127

Instructor: Yuchong Zhang

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- *Office Hours:* Wed 10am-noon or by appointment

Teaching assistants:

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- *Office Hours:* ~~TBA~~ Wed 3pm-5pm (SS 623B)

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Course website: Quercus (You should NOT distribute the course material without permission.)

Description of this course: Mathematical theory and probabilistic tools for modeling and analyzing security markets are developed. Topics include pricing derivative securities in complete and incomplete markets, Brownian motion and stochastic calculus, the Black-Scholes model, and term structure of interest rates. We will spend about one third of the course on discrete-time models, and two thirds of the course on continuous-time models. Prerequisite to this course is calculus-based probability theory at the level of ACT350/STA347. ACT370 is strongly recommended.

Reference Books:

- Steven Shreve: *Stochastic Calculus for Finance I & II.* (Main reference)
  (Please check http://www.math.cmu.edu/users/shreve/ for errata.)
- Tomas Björk: *Arbitrage Theory in Continuous Time.*
- Martin Baxter and Andrew Rennie: *Financial Calculus: An Introduction to Derivative Pricing.*
- X. Sheldon Lin: *Introductory Stochastic Analysis for Finance and Insurance.*
- John Hull: *Options, Futures and Other Derivatives*

Grading: Your course grade will be determined by the performance on homework (15%), a midterm exam (35%) and a final exam (50%).

Exam dates and policy:

- Midterm exam: October 23, 2018 (in class)
- Final exam: All students must take the final at the time scheduled by the university.

All exams will be closed-book, but you are allowed to bring a two-sided, 3" x 5" index card for each exam. You may bring a simple calculator (non-programmable, no wi-fi function). No other electronic devices.

Homework: There will be 5 homework. The tentative due dates are 11:59am on Sept 27, Oct 11, Nov 1, Nov 22 and Dec 6. Late homework are not accepted. There will be two in-class tutorials conducted by a TA to cover basic Excel/R skills for financial modeling.

While you may discuss the homework problems with a partner, you must write down, understand and submit your own solutions. Your reasoning must be clear and complete for full credit. Submit your solution as a hardcopy, unless otherwise stated. Only selected problems will be graded.

Academic Integrity:

The University of Toronto's intellectual community relies on academic integrity and responsibility as the cornerstone of its work. As a student, you alone are responsible for ensuring the integrity of your work and for understanding what constitutes an academic offence. Please visit `http://www.artsci.utoronto.ca/osai/students` for the rules and expectations, and tips on how to avoid committing an academic offence. Failure to observe these rules of conduct will have serious academic consequences, up to and including expulsion from the university.

The following is a tentative guide as to how the course will proceed:

- Lecture 1: Derivative security, no-arbitrage pricing
- Lecture 2: Binomial model, review of probability theory
- Lecture 3: Risk-neutral pricing, CRR formula, binomial model calibration, American option
- Lecture 4: Trinomial model, incomplete markets, Excel and R programming for option pricing
- Lecture 5: Brownian motion, reflection principle, barrier option
- Lecture 6: Stochastic integral, Itô's lemma
- Lecture 7: Midterm
- Lecture 8: Black-Scholes analysis, Fundamental Theorem of Asset Pricing
- Lecture 9: Greeks, implied volatility, American option
- Lecture 10: Stochastic differential equations, Feynman-Kac formula, R programming for option pricing
- Lecture 11: Short rate models
- Lecture 12: Forward rate models