Mathematics of Financial Options

Financial Mathematics 3613b

Winter 2019 Course Outline

Instructor Information

Instructor: S. Liu
Office: WSC 214A
E-mail: sliu49@uwo.ca
Phone 519-661-2111 ext TBA
Office Hours: Wednesday 7:30pm-8:30pm
Lecture Hours: Monday 6:30-8:30pm and Wednesday 6:30pm-7:30pm in WSC240

Course Information

Course Description

An introduction to modern financial mathematics using a differential equations approach. Stochastic differential equations and their related partial differential equations. The Fokker-Planck and Kolmogorov PDEs. No-arbitrage pricing, the Black-Scholes equation and its solutions. American options. Exotic options.

Prerequisites

SS2503A/B Applied Mathematics 2402A or the former Differential Equations 2402A;
or Statistical Sciences 2503A/B (or the former Applied Mathematics 2503A/B).
Applied Mathematics 2402A or the former Differential Equations 2402A;
or Statistical Sciences 2503A/B (or the former Applied Mathematics 2503A/B).

Antirequisites

The former Applied Mathematics 3613A/B

Pre, Co-requisites Warning

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. You can be deregistered at any time even after writing the final exam. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites

Textbook

Matt Davison, Quantitative Finance: A Simulation--Based Introduction Using Excel, CRC Press, (2014)

Course Objectives

This course is about modern financial mathematics -- the study of making financial decisions under uncertainty. Such decisions are shaped by three main drivers – the balance between future and present, quantified by the interest rate; the role of uncertainty, often quantified in terms of the volatility, and investors attitudes toward risk. Several products are available to trade and manage risk: stocks and bonds at a basic level; forwards, futures, and options at a more advanced level. We will develop theories for pricing and hedging both individual securities and portfolios of them. By the end of the course we will understand two Nobel-prize winning economic theories – the Capital Asset Pricing Model of Markowitz, Sharpe, and Miller (Nobel Prize 1990) and the Black-Scholes-Merton theory of options pricing (Nobel Prize 1997). We will learn how to price and hedge a variety of stock options and briefly discuss the challenges involved in extending this pricing technology to options on other underlying assets. Along the way we will use mathematics ranging from basic stochastic calculus and linear differential equations to the asymptotic expansion of integrals.

The topics covered are:

1) Intuition about uncertainty and risk
2) The classical approach to decision making under uncertainty
3) Repaying loans over time
4) Bond pricing with default: using difference equations
5) Tranching and collateralized debt obligations
6) Modeling stock prices
7) Mean-variance portfolio optimization
8) A qualitative introduction to options
9) Pricing options using binomial trees
10) Random walks
11) Black Scholes PDE for pricing options in continuous time
12) Solving the Black Scholes PDE
13) Some approximate values of the Black Scholes call formula

Assessment

Assignments and/or Quizzes

I will be assigning questions as we go for your practice at home. The midterms and the final exam will use some of these questions and material from the textbook and lecture notes.

Midterms or Tests (temporary scheduled time)

Midterm test 1 (Monday, February 11, 6:30pm-8:30pm, in WSC240)
Midterm test 2 (Monday, March 18, 6:30pm-8:30pm, in WSC240)

Final Exam

The final exam will be during the regular exam period. It will cover all of the course material.

Evaluation

Midterm 1 - 25%
Midterm 2 - 25%
Essay - 10%
Final Exam - 40%

Computing and/or Calculator Requirement

Only basic scientific calculators will be allowed in tests or exams (to be precise, calculators with a memory buffer smaller than 10 characters).

Department Policy on Missed Course Requirements

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to your Dean's office as soon as possible, and contact your instructor immediately. If accommodation is approved by your Dean's office, your instructor will be notified, then it is your responsibility to make alternative arrangements with your instructor. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see: http://www.stats.uwo.ca/accommodation_medical.pdf.
A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility. The form can be found at: http://www.stats.uwo.ca/medicalform.pdf.
Or, request a Record's Release Form (located in the Dean's Office) for visits to Student Health Services.

Missed Midterm or Quiz: The policy of the department of Statistical and Actuarial Sciences is that there will be no make-up exams or quizzes for a missed midterm or a quiz. For those that do legitimately miss a midterm or a quiz and provide the required supporting documentation, the standard practice will be that the weight of the midterm or the quiz will be reassigned to the final exam. If your reason is not deemed valid, then you will receive a mark of 0.

Student Health and Wellness: As part of a successful student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page http://www.music.uwo.ca/, and our own McIntosh Gallery http://www.mcintoshgallery.ca. Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca/. Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at http://www.health.uwo.ca/mental_health/resources.html. To help you learn more about mental health, Western has developed an interactive mental health learning module, found here:
http://www.health.uwo.ca/mental_health/module.html. This module is 30 minutes in length and provides participants with a basic understanding of mental health issues and of available campus and community resources. Topics include stress, anxiety, depression, suicide and eating disorders. After successful completion of the module, participants receive a certificate confirming their participation.

Email Communication

E-mail can be used to ask a brief question and if you need lengthier discussions, you may raise them during the office hours or by appointment.
Please remember that I will only read e-mails from your UWO student account. The subject line should contain "FM3613".

Attendance

Classroom attendance is viewed as an important part of the learning process. Students are advised that excessive absenteeism may result in the student being disbarred from the final exam (see Western Academic Calendar).

Classroom Environment

The Department has adopted a "Mutual Expectations" policy governing the classroom environment and all work submitted by students. The full text of the policy can be found at: http://www.stats.uwo.ca/mutual_expectations.pdf.
In summary, the policy was developed under the premise that all interactions between students and faculty should be governed by the principles of courtesy, respect and honesty.