昆山杜克大学
DUKE KUNSHAN UNIVERSITY

MATHEMATICS 381K

Intermediate Mathematical Finance

Spring 2016

Dates / contact hours:	300 contact minutes / week for 7 weeks (as per Duke requirements)
Academic Credit:	1 course
Areas of Knowledge:	QS
Modes of Inquiry:	not coded for Modes of Inquiry
Course format:	lecture & discussion; group oral presentations (can accommodate up to 25 students)

Instructor's Information

Jian-Guo Liu, Professor, Department of Physics and Department of Mathematics

Prerequisite(s), if applicable

Multivariable Calculus (Math 212 or 222 or equivalent) required; some basic probability would be useful but not necessary. Basic probability needed for the course can be covered / explained during lectures. No linear algebra necessary.

Course Description

Elementary concepts and tools of mathematical finance for students with solid mathematics background. The focus is quantitative methods and logical thinking to help students understand pricing of derivative securities, portfolio management, and related questions. Topics include: Review of probability, random variables, concepts of Brownian motion, present value analysis, notions of arbitrage and arbitrage theorem, Black-Scholes formula, applications on options. The course should appeal to students who plan to work in the finance industry, students who intend to enroll in a professional Master's Degree program in finance, and students from other fields who want an in-depth understanding of how financial markets actually work.

Course Goals / Objectives

The overall course goal is for students to understand how and why financial markets operate the way they do. Students will master basic concepts of financial models used on Wall Street and other markets and develop basic computational skills in financial engineering. Logical thinking skills will be improved through classroom discussions and homework assignments. Quizzes, homework assignments, exams, and group projects will be aligned with specific course objectives.

Required Text(s)/Resources

S. M. Ross, An Elementary Introduction to Mathematical Finance, Cambridge University Press, Third Ed., 2011; ISBN 978-0-5-2119253-8

Recommended Text(s)/Resources

John C. Hull, Options, Futures, and Other Derivatives, Eighth Ed., (Prentice Hall NJ 2011)

Additional Materials (optional)

Lecture Notes and PowerPoint

Course Requirements / Key Evidences

The course will follow the order of the textbook. There will be 3 in-class quizzes, 5 homework assignments, 1 midterm exam, a final exam, and group projects. Participation in classroom discussions is required.

Students will receive grades based on a point system as follows: three quizzes (5% each = 15%), 5 homework assignments (5% each = 25%), group project (15%), one midterm (10%), classroom participation (10%), and a final exam (25%).

Group projects will be on some computational problem such as the pricing of options and calibration of volatilities, simulation of geometric Brownian motion, the binomial tree model, finite difference solvers for the Black-Scholes models, portfolio management, comparison between US and Chinese markets, etc. Students will be able to develop and refine their project ideas through close consultation with the instructor.

Technology Considerations, if applicable

The Duke Sakai system will be used.

Assessment Information / Grading Procedures

Students will receive grades based on homework assignments, exams, classroom participation, and group oral presentations. Detailed rubrics for assignments and exams will be handed out ahead of time and explained to the students so that they understand what is expected of them and how grades are assigned.

Diversity and Intercultural Learning (see Principles of DKU Liberal Arts Education)

The instructor has extensive experience in the university systems and cultures of both China and the US. Many of his US courses have had PRC students, most of whom have strong mathematical backgrounds. The concepts covered in the course are usually equally familiar (or unfamiliar) to EFL and English-as-a-first-language students. The instructor uses the first one or two classes to gauge the backgrounds, interests, and participation styles of the students. For the Duke Kunshan course, the instructor will also send a brief survey to enrolled students before the beginning of class in order to obtain information about levels of mathematical skills, student expectations, etc. Because the course does not require extensive amounts of reading (as would a humanities course, for example), EFL students usually are not at a disadvantage in comparison to their non-EFL classmates. Students will be expected to participate in classroom discussions and part of their grade (10%) will be based on this participation. Special care will be taken to ensure that the quieter students (or those less confident of their English skills) will have equal opportunity to contribute to discussions.

Course Policies and Guidelines

- **COURSE POLICIES AND GUIDELINES:**
  Instructors' expectations for all assignments and activities will be made as explicitly as possible, given the likelihood of a wide range of background conventions and habits among the students. The Duke Kunshan University Community Standard will be discussed and adhered to.

- **ACADEMIC INTEGRITY:**
  Each student is bound by the academic honesty standard of Duke Kunshan University. Its Community Standard states: "Duke Kunshan University is a community composed of individuals of diverse cultures and backgrounds. We are dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Members of this community commit to reflect upon and uphold these principles in all academic and non-academic endeavors, and to protect and promote a culture of integrity." Violations of the DKU academic honesty standard will not be tolerated. Cheating, lying, falsification, or plagiarism in any practice will be considered as an inexcusable behavior and will result in zero points for the activity.

- **CLASS ATTENDANCE:**
  Students are responsible for all the information presented in class. Class attendance and participation are important components of the learning experience. All students are expected to participate during class time.

- **POLICY ON MAKE-UP WORK/EXAMS:**

Students are allowed to make up work only if missed as a result of illness or other unanticipated circumstances warranting a medical excuse, consistent with DKU policy. You must notify the instructor in advance if you will miss an exam or project deadline. Project extensions requested for medical reasons must be negotiated at the time of illness.

The use of mobile phones, tablets, and laptops is not permitted during the class, except when approved by the instructor.

Tentative Course Outline or Schedule

The class meets 3 times a week for 100 minutes for each session.

Syllabus

Corresponding sections in the textbook are given in parentheses. Each class period will be a combination of material presented by the professor, in-class discussion, and Q&A sessions. Each quiz covers material from one week's worth of work whereas the midterms cover the previous two week's work (with emphasis on the second week material).

Week 1: introduction

Class 1: Savings accounts, stocks, commodities, currencies, trading at stock exchanges

Class 2: Options, short selling, reasons for buying options, investment strategy with stocks and options (Ch. 4)

Class 3: Interest rates and present value analysis (Ch. 4), Quiz #1, Homework #1 due

Week 2: Review of probability I and models

Class 1: Outcomes, events, probability, independence
(Ch. 1)

Class 2: Binomial model for stock prices
(Ch. 6.2)

Class 3: Investment strategy with stocks and options, pricing options (Ch. 5)
Homework #2 due

Week 3: Risk-neutral and arbitrage analysis

Class 1: No arbitrage principle,
Option Pricing (Ch. 5)

Class 2: Interpretation of risk-neutral measure and complete (Ch. 6)

Class 3: Arbitrage analysis (Ch. 6), Quiz #2, Homework #3 due. Group projects assignments

Week 4: Review of probability II

Class 1: Continuous random variables, normal distribution
(Ch. 2) Midterm exam

Class 2: Interesting models (Ch. 2)

Class 3: Basic concepts of geometric Brownian motion (Ch. 3)
Homework #4 due; group projects progress reports

Week 5: Black-Scholes theory

Class 1: Hedging strategies (Ch. 7)

Class 2: Black-Scholes model (Ch. 7)

Class3: Black-Scholes formula and algorithm for European option (Ch. 7), Quiz #3, Homework #5 due

Week 6: American and other options

Class 1: American options (Ch. 5.2, 8.3, 13)

Class 2: Computing option price for several initial stock prices (Ch. 5.2, 8.3, 13)

Class3: Algorithm for American options (Ch. 5.2, 8.3, 13); group projects discussion

Week 7: Monte-Carlo simulations and class projects

Class 1: Introduction to Monte-Carlo simulation

Class2: Monte-Carlo option pricing (Ch. 13.4)

Class 3: group projects presentations

Final Exam

21 October 2015 version
Revised for Robisheaux committee