ACTS:4380 Mathematics of Finance II

Fall 2016
3:30 p.m. – 4:20 p.m., MWF, at 60 SH

1   Contact information

- **Instructor:** Professor Ambrose Lo, PhD, FSA, CERA

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      (Note: Please specify "ACTS:4380" in the subject line)
    - *Office hours:* 2:30 p.m. − 3:30 p.m., Monday, Wednesday, Friday, and by appointment

- **Grader:** Mr. Siyang Tao

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2   Course description and objectives

Building upon the conceptual foundation on financial derivatives in the prerequisite course ACTS:4130 (Quantitative Methods for Actuaries), this intermediate course on mathematical finance for B.S. and M.S. in Actuarial Science students explores option pricing in a reasonably mathematical level and prepares you adequately for the Society of Actuaries' Exam MFE (Models for Financial Economics). It consists of three interrelated parts of increasing level of technical sophistication:

Part I. Discrete-time option pricing models (approx. 3 weeks)

Part II. Continuous-time option pricing models (approx. 9 weeks)

Part III. Interest rate derivatives (approx. 3 weeks)

The overarching theme of the course is to determine the fair price of an option in the context of different pricing models. After taking this course, you are expected to:

- Price options on a wide variety of underlying assets using different pricing methodologies.

- Understand the assumptions and limitations of each class of option pricing models.

- Take and, most importantly, pass Exam MFE with considerable ease.

- Proceed to more advanced courses on mathematical finance with strong confidence.

3   Exam MFE

In Fall 2016, Exam MFE will be offered via computer-based testing (CBT) in **November (17–23)**. The registration deadline is October 5. It is strongly suggested that you take the exam in November as you learn the material and study for the quizzes and exams in this course (strike while the iron is hot!). In the "unlikely" event that you cannot pass the exam in November, you should retake it in March 2017.

Exam MFE is a three-hour exam that consists of 30 multiple-choice questions. Historically, the passing mark is **72%** of the full score[i] and the passing rate is stable at 47–49%. There are two released past exams (Spring 2007 and Spring 2009) and 76 sample questions with detailed solutions. More information about Exam MFE (e.g. syllabus) can be found at `https://www.soa.org/education/exam-req/edu-exam-mfe-detail.aspx`.

4   Texts

As in ACTS:4130, there are no required textbooks in this course. We shall follow closely the course lecture notes, regarded as a mini-textbook, which will be made available on ICON (`http://icon.uiowa.edu`) chapter by chapter. The notes not only address all important topics required in Exam MFE, but also equip you with lots of intuition to understand the subject matter deeply,

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[i]Out of the 29 graded questions (it is likely that one or two of the 30 questions are pilot questions that are not graded), you need at least 21 correct.

and a wide variety of examples and practice problems for exam preparation. *Please print out and bring a copy of the lecture notes for each class meeting.*

The recommended text is

McDonald, R.L., 2013. Derivatives Markets (Third Edition). Pearson.

This is the official textbook for Exam MFE. We shall cover, in a different but more cohesive order, the following required sections in the SOA Exam MFE syllabus:

- *Chapter 10: Binomial Option Pricing: Basic Concepts* (excluding "Options on Commodities" on pages 315 and 316)

- *Chapter 11: Binomial Option Pricing: Selected Topics*, Sections 11.1–11.3, Appendices 11.A and 11.B

- *Chapter 12: The Black-Scholes Formula* (Sections 12.1–12.5, Appendix 12.A)

- *Chapter 13: Market-Making and Delta-Hedging* (including Appendix 13.B)

- *Chapter 14: Exotic Options: I*

- *Chapter 18: The Lognormal Distribution*

- *Chapter 19: Monte Carlo Valuation*, Sections 19.1–19.5

- *Chapter 20: Brownian Motion and Itô's Lemma*, Sections 20.1–20.3 (up to but excluding "Modeling Correlated Asset Prices" on pages 612–613), 20.4 (excluding "Multivariate Itô's Lemma" on pages 616–617), 20.5–20.6 (up to but excluding "Valuing a Claim on $S^a Q^b$ on pages 621–622)

- *Chapter 21: The Black-Scholes-Merton Equation*, Sections 21.1–21.2 (excluding "What If the Underlying Asset Is Not an Investment Asset" on pages 635–637) and 21.3 (excluding "The Backward Equation" on pages 637–638, and excluding the last two paragraphs of the section on page 639)

- *Chapter 23: Exotic Options: II*, Section 23.1 (but with only those definitions in Tables 23.1 and 23.2 that are relevant to Section 23.1)

- *Chapter 24: Volatility*, Sections 24.1–24.2 (up to the second paragraph on page 721, but including footnote 4 on page 721 and the top panel in Figure 24.3 on page 723)

- *Chapter 25: Interest Rate and Bond Derivatives*, Sections 25.1–25.4 (up to the first paragraph on page 773), 25.5 (excluding "LIBOR Market Model" on pages 781–783), Appendix 25.A (this appendix contains only a reference to the following site for download, `http://wps.aw.com/wps/media/objects/14728/15081864/appendices/McDonald-web-25-A.pdf`)

Chapter 9: Parity and Other Option Relationships will be left as self-study.

Pearson has published *Student Solutions Manual to Derivatives Markets*, which provides solutions to all even-numbered end-of-chapter problems in the text.

5   Tentative teaching, assignment and quiz schedule

This approximate schedule will be updated as needed as the semester progresses.

Teaching Week	Lecture	Date	Topic
Part I: Discrete-time option pricing models			
1	L01	August 22, 2016 (Mon)	Chapter 1*
	L02	August 24, 2016 (Wed)	Chapter 1
	L03	August 26, 2016 (Fri)	Chapter 1
2	L04	August 29, 2016 (Mon)	Chapter 1
	L05	August 31, 2016 (Wed)	Chapter 1, Assignment 1
	L06	September 2, 2016 (Fri)	Chapter 1, **Quiz 1**
3	—	September 5, 2016 (Mon)	(University Holiday)
	L07	September 7, 2016 (Wed)	Chapter 1, Assignment 2
	L08	September 9, 2016 (Fri)	Chapter 1
Part II: Continuous-time option pricing models			
4	L09	September 12, 2016 (Mon)	Chapter 2
	L10	September 14, 2016 (Wed)	Chapter 2, Assignment 3
	L11	September 16, 2016 (Fri)	Chapter 2, **Quiz 2**
5	L12	September 19, 2016 (Mon)	Chapter 3
	L13	September 21, 2016 (Wed)	Chapter 3, Assignment 4
	L14	September 23, 2016 (Fri)	Chapter 3
6	L15	September 26, 2016 (Mon)	Chapter 3
	—	September 28, 2016 (Wed)	(No class due to Actuarial Job Fair)
	L16	September 30, 2016 (Fri)	Chapter 3, **Quiz 3**
7	L17	October 3, 2016 (Mon)	Chapter 4
	L18	October 5, 2016 (Wed)	Chapter 4, Assignment 5
	L19	October 7, 2016 (Fri)	Chapter 4
8	L20	October 10, 2016 (Mon)	Chapter 5
	L21	October 12, 2016 (Wed)	Chapter 5, Assignment 6
	L22	October 14, 2016 (Fri)	Chapter 5, **Quiz 4**
9	L23	October 17, 2016 (Mon)	Chapter 5
	L24	October 19, 2016 (Wed)	Chapter 5, Assignment 7
	L25	October 21, 2016 (Fri)	Chapter 6
10	L26	October 24, 2016 (Mon)	Chapter 6
	L27	October 26, 2016 (Wed)	Chapter 6, Assignment 8
	L28	October 28, 2016 (Fri)	Chapter 7, **Quiz 5**
11	L29	October 31, 2016 (Mon)	Chapter 7
	L30	November 2, 2016 (Wed)	Chapter 7, Assignment 9
	L31	November 4, 2016 (Fri)	Chapter 7
12	L32	November 7, 2016 (Mon)	Chapter 7
	—	November 9, 2016 (Wed)	**(No class due to Midterm Exam)**
	L33	November 11, 2016 (Fri)	Chapter 7
Part III: Interest rate derivatives			

13	L34	November 14, 2016 (Mon)	Chapter 8
	L35	November 16, 2016 (Wed)	Chapter 8, Assignment 10
	L36	November 18, 2016 (Fri)	Chapter 8, **Quiz 6**
—	—	November 21, 2016 (Mon)	(Thanksgiving Week - No class!)
	—	November 23, 2016 (Wed)	
	—	November 25, 2016 (Fri)	
14	L37	November 28, 2016 (Mon)	Chapter 9
	L38	November 30, 2016 (Wed)	Chapter 10, Assignment 11
	L39	December 2, 2016 (Fri)	Chapter 10
15	L40	December 5, 2016 (Mon)	Chapter 10
	L41	December 7, 2016 (Wed)	Chapter 10
	L42	December 9, 2016 (Fri)	Chapter 10 / Review

* Refer to the numbering in the lecture notes

6   Grading system

Assessment in this course comprises the following items:

1. **Attendance: $\pm\varepsilon\%$**

   You may choose to attend or not to attend classes, but everyone needs to be aware that absence from classes without a valid reason can negatively affect your final grade. It is also impossible to get a copy of any course material you miss and inquire about any announcements made in class.

2. **Assignments: 15%**

   There will be regular weekly assignments consisting of a few end-of-chapter problems in the lecture notes, usually assigned on Wednesday and due the next Wednesday. Late homework will be severely penalized (see the instructions on the assignment sheet). Illustrative solutions will be provided on ICON.

   A note on collaboration: Discussion with other students on homework problems is encouraged. However, what you hand in must ultimately be your own work.

3. **Short quizzes: 15%**

   There will be a 15-minute quiz about every 2 weeks, for a total of 6 quizzes throughout the semester. These quizzes are intended to motivate you to study regularly (not just cram before the Midterm and Final Exams!) and will consist of reasonably straightforward questions. The quiz with the lowest score will be dropped when it comes to computing the final grade. No make-up quizzes will be given.

4. **Midterm Exam: 30%**

   There will be a two-hour written Midterm Exam to be held in the evening (6:30 p.m. – 8:30 p.m.) of **November 9, 2016 (Wednesday)** testing the material in Chapters 1 to 7 of this

course. As an immediate precursor of Exam MFE in November 2016, this midterm serves as a mock exam. It will consist mainly of a series of short computational questions similar in style to SOA Exam MFE problems and/or problems in the lecture notes. You will therefore find that problems from released Exam MFE past/sample exams and the lecture notes are useful in preparing for the Midterm Exam.

5. **Final Examination: 40%**

   A two-hour comprehensive written examination will take place in the week of December 12–16, 2016. Like the Midterm Exam, it comprises mainly short computational questions similar in style to SOA Exam MFE problems and/or problems in the lecture notes. The exact date and time will be announced by the Registrar in mid-September. Please do not plan your end-of-semester travel plans until the final exam schedule is made public. It is your responsibility to know the date, time, and place of the final exam.

All quizzes and exams in this course are closed-book and no formula sheet is allowed (and on all SOA exams as well!). Only SOA/CAS-approved calculators listed on Point 9 of `https://www.soa.org/Files/Edu/edu-rules-reg-instructions.pdf` are allowed.

Note on absence from exams. If, for medical reasons, you are unable to take any exam in this course, you should inform the course instructor *within 48 hours* of the exam, and submit original documentation as soon as possible. Otherwise, a zero score will be awarded. Absence for other reasons will not be allowed, unless approval from the instructor is sought well in advance.

Grading scheme. Plus or minus grading system will be used in this course, and undergraduate and graduate students will be treated as two separate groups when it comes to assigning final grades. An *approximate* guide is as follows:

Undergraduate students					
A-	$[83.5, 89)$	A	$[89, 94.5)$	A+	$[94.5, 100]$
B-	$[67, 72.5)$	B	$[72.5, 78)$	B+	$[78, 83.5)$
C-	$[50.5, 56)$	C	$[56, 61.5)$	C+	$[61.5, 67)$
D-	$[34, 39.5)$	D	$[39.5, 45)$	D+	$[45, 50.5)$
F	$[0, 34)$				

Graduate students					
A-	$[85, 90)$	A	$[90, 95)$	A+	$[95, 100]$
B-	$[70, 75)$	B	$[75, 80)$	B+	$[80, 85)$
C-	$[55, 60)$	C	$[60, 65)$	C+	$[\mathbf{65}, 70)$
D-	$[40, 45)$	D	$[45, 50)$	D+	$[50, 55)$
F	$[0, 40)$				

These are not completely absolute scales and the instructor reserves the "option" to adjust the cutoffs. Note that with this grading scheme you are not "graded on a curve", and so you are not competing with fellow students. Therefore, you are not penalized in any way for working together to better understand concepts and to perform better in this course.

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About the instructor. Professor Ambrose Lo earned his B.S. in Actuarial Science (first class honors) and Ph.D. in Actuarial Science from The University of Hong Kong in 2010 and 2014 respectively. He joined the Department of Statistics and Actuarial Science at The University of Iowa in August 2014 as an Assistant Professor in Actuarial Science. He is a Fellow of the Society of Actuaries (FSA) and a Chartered Enterprise Risk Analyst (CERA). His research interests lie in dependence structures, quantitative risk management as well as optimal (re)insurance. His research papers have been published in top-tier actuarial journals, such as *Insurance: Mathematics and Economics* and the *Scandinavian Actuarial Journal*.

Besides dedicating himself to actuarial research, Ambrose attaches equal importance to teaching, through which he nurtures the next generation of actuaries and serves the actuarial profession. He has taught courses on financial derivatives, mathematical finance, life contingencies, credibility theory and advanced probability theory. His emphasis in teaching is always placed on concrete problem-solving skills complemented by a thorough understanding of the subject matter. He is also the sole author of ACTEX CAS Exam S Study Manual (Fall 2016 Edition).

College of Liberal Arts & Sciences: Policies and Procedures

Administrative Home

The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall, or see the CLAS Academic Policies Handbook at `http://clas.uiowa.edu/students/handbook`.

Electronic Communication

University policy specifies that students are responsible for all official correspondences sent to their University of Iowa e-mail address (@uiowa.edu). Faculty and students should use this account for correspondence (Operations Manual, III.15.2. Scroll down to k.11).

Accommodations for Disabilities

The University of Iowa is committed to providing an educational experience that is accessible to all students. A student may request academic accommodations for a disability (which include but are not limited to mental health, attention, learning, vision, and physical or health-related conditions). A student seeking academic accommodations should first register with Student Disability Services and then meet with the course instructor privately in the instructor's office to make particular arrangements. Reasonable accommodations are established through an interactive process between the student, instructor, and SDS. See `http://sds.studentlife.uiowa.edu/` for information.

Academic Honesty

All CLAS students or students taking classes offered by CLAS have, in essence, agreed to the College's Code of Academic Honesty: "I pledge to do my own academic work and to excel to the best of my abilities, upholding the IOWA Challenge. I promise not to lie about my academic work, to cheat, or to steal the words or ideas of others; nor will I help fellow students to violate the Code of Academic Honesty." Any student committing academic misconduct is reported to the College and placed on disciplinary probation or may be suspended or expelled (CLAS Academic Policies Handbook).

CLAS Final Examination Policies

The final examination schedule for each class is announced by the Registrar generally by the fifth week of classes. Final exams are offered only during the official final examination period. **No exams of any kind are allowed during the last week of classes.** All students should plan on being at the UI through the final examination period. Once the Registrar has announced the date,

time, and location of each final exam, the complete schedule will be published on the Registrar's web site and will be shared with instructors and students. It is the student's responsibility to know the date, time, and place of a final exam.

Making a Suggestion or a Complaint

Students with a suggestion or complaint should first visit with the instructor (and the course supervisor), and then with the departmental DEO. Complaints must be made within six months of the incident (CLAS Academic Policies Handbook).

Understanding Sexual Harassment

Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassmentfor assistance, definitions, and the full University policy.

Reacting Safely to Severe Weather

In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit the Department of Public Safety website.

END OF COURSE SYLLABUS