University of Iowa

ACTS:4380
Mathematics of Finance II
Course Syllabus
Spring 2017

MWF, 40 SH
4:30 p.m. – 5:20 p.m.

COLLEGE OF
LIBERAL ARTS & SCIENCES
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Department of Statistics and Actuarial Science

1 Contact information

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    (Note: Please include "ACTS:4380" in the subject line)
  - *Personal homepage:* `https://sites.google.com/site/ambroseloyp`
    (This page is mainly about my research endeavors. Feel free to visit it from time to time!)
  - *Office hours:* 2:30 p.m. – 3:30 p.m., Monday, Wednesday, Friday, and by appointment
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    (Note: Please include "ACTS:4380" in the subject line)
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2 Course description and objectives

Building upon the conceptual foundation on financial derivatives developed in the second part of Society of Actuaries (SOA) Exam FM, this intermediate course on mathematical finance for B.S. and M.S. in Actuarial Science students explores option pricing in a reasonably mathematical manner and prepares you adequately for the SOA **Models for Financial Economics (MFE) Exam**. It consists of four interrelated parts of varying degrees of technical sophistication:

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

Part II. Continuous-time option pricing models (approx. 8 weeks)

Part III. Interest rate derivatives (approx. 2 weeks)

Part IV. Epilogue: General properties of option prices (approx. 2 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 in July 2017 with considerable ease.
- For graduate students, proceed to more advanced courses on mathematical finance with strong confidence.

3 Exam MFE

Exam MFE is a three-hour exam that consists of 30 multiple-choice questions. Historically, the pass 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 can be found at `https://www.soa.org/education/exam-req/edu-exam-mfe-detail.aspx`.

In 2017, Exam MFE will be offered via computer-based testing (CBT) in March (10–16), **July (6–12)** and November (16–22) (please refer to `https://www.soa.org/Education/Exam-Req/Exam-Day-Info/edu-2017-cbt-test-schedule.aspx`). The registration deadlines are February 7, May 31 and October 10 respectively. It is strongly suggested that you take the exam in **July** after you fully grasp the material and study for the quizzes and exams in this course. Taking the exam in March, which is based on a more difficult syllabus (see below), is very "risky" and not a behavior typical of a prudent actuary.

Note that effective with the July 2017 administration of Exam MFE, there will be noticeable changes in the syllabus. According to the SOA, these changes were motivated by two factors.

1. Return Exam FM to its former coverage of theory of interest topics. With the exception of interest rate swaps, all derivatives material will be moved to Exam MFE.

[i] Out of the 28 or 29 graded questions (it is likely that one or two of the 30 questions are pilot questions that are not graded), you need 21 correct.

2. Remove some of the more mathematically sophisticated topics from Exam MFE, in particularly those related to stochastic calculus. It is more appropriate for those topics to be covered in fellowship exams as needed for each track.

In short, the financial derivatives material which you should have learnt from Exam FM (or the one-study-hour prep course ACTS:3210/4160 at UI) is now shifted to Exam MFE. Meanwhile, some hard topics in the old MFE syllabus have been deleted *(hurray!)*. **Please note that ACTS:4380 in this spring session will focus on the July 2017 Exam MFE syllabus, which is a considerably easier exam syllabus.**

4 Text

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. These notes not only address all important topics required in Exam MFE, but also present lots of intuition for you to understand the subject matter deeply, and a wide variety of examples and practice problems for exam preparation. *Please print out and bring a copy of the relevant portions of the lecture notes for each class meeting.*

The recommended text for this course is

> McDonald, R.L., 2013. *Derivatives Markets* (Third Edition). Pearson, New Jersey. ISBN: 978-0-32154-308-0.

This is the official textbook for Exam MFE (both for the old syllabus and new syllabus). We shall cover, in a different but more cohesive order, the following required sections in the July 2017 MFE syllabus:

- Chapter 1: Introduction to Derivatives
- Chapter 2: An Introduction to Forwards and Options, Sections 2.1–2.4
- Chapter 3: Insurance, Collars, and Other Strategies
- Chapter 5: Financial Forwards and Futures, Sections 5.1–5.2, Section 5.3 (through the middle of p.136), Section 5.4 (through the top of p.143)
- Chapter 9: Parity and Other Option Relationships
- Chapter 10: Binomial Option Pricing, Sections 10.1–10.5, Section 10.6 (through the middle of p.315)
- Chapter 11: Binomial Option Pricing, Sections 11.1–11.3, Appendix 11.A
- Chapter 12: The Black-Scholes Formula, Sections 12.1–12.5, Appendix 12.A, Appendix 12.B
- Chapter 13: Market-Making and Delta-Hedging
- Chapter 14: Exotic Options: I, Sections 14.1–14.3, Section 14.4 (through the bottom of p.419), Sections 14.5–14.6

- Chapter 18: The Lognormal Distribution, Sections 18.1–18.5, Appendix 18.A
- Chapter 19: Monte Carlo Valuation, Sections 19.1–19.5
- 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), the top half of p.714 (Re: Lookback calls and puts)
- Chapter 25: Interest Rate and Bond Derivatives, Section 25.1 (through the bottom of p.754), Section 25.4 (through the middle of p.773), Section 25.5 (through the middle of p.781)
- Appendices B.1 (The Language of Interest Rates), and C (Jensen's Inequality)

Unless otherwise stated, chapter appendices are not included in the required readings from McDonald (2013). Pearson has published *Student Solutions Manual to Derivatives Markets*, which provides solutions to all even-numbered end-of-chapter problems in the text.

You should have come across Chapters 1, 2, 3 and 5 of McDonald (2013) while studying the second part of Exam FM (or taking the one-study-hour prep course ACTS:3210/4160). Towards the end of this course, we shall review these chapters and point out subtleties to prepare you for the July 2017 MFE exam.

5 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 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: 18%**

   There will be weekly assignments consisting of three to five 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). For students' edification, illustrative solutions will be posted on ICON shortly after each homework is due.

   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: 17%**

   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 relatively straightforward questions. The quiz with the lowest score will be dropped when it comes to computing the final grade.

4. **Midterm Examination: 25%**

   There will be a 90-minute written Midterm Examination to be held in the evening (6:30 p.m. – 8:00 p.m.) of **March 29, 2017 (Wednesday)** at 140 SH testing the material in Chapters 1 to 5 of this course. It will consist mainly of a series of short computational questions similar in style to MFE problems and/or problems in the lecture notes. You will therefore find that problems from released 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 May 8–12, 2017. Like the Midterm Exam, it comprises mainly short computational questions similar in style to MFE problems and/or problems in the lecture notes. The exact date and time will be announced by the Registrar in mid-February. 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 you are not allowed to bring your own formula sheet (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 permitted.

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+	$[\underline{\mathbf{65}}, 70)$
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.

IMPORTANT NOTE

1. A grade of C+ or higher in this course is a prerequisite for ACTS:6160 (Topics in Actuarial Science), which will be offered in Fall 2017 for graduate students.
2. This is *not* an easy course for most students, *even for those who have passed Exam MFE*. Each week you should spend at least 3 hours outside of class meetings reviewing the course notes and working on the end-of-chapter problems. It is fine to work harder, but working less is risky. Let me know if you encounter any problems with your learning.

6 Tentative teaching, assignment and quiz schedule

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

Teaching Week	Lecture	Date	Topic[ii]
Part I: Discrete-time option pricing models			
1	—	January 16, 2017 (Mon)	(University Holiday)
	—	January 18, 2017 (Wed)	(Instructor was sick ☹)
	L01	January 20, 2017 (Fri)	Chapter 1
2	L02	January 23, 2017 (Mon)	Chapter 1
	L03	January 25, 2017 (Wed)	Chapter 1
	L04	January 27, 2017 (Fri)	Chapter 1, Assignment 1
3	L05	January 30, 2017 (Mon)	Chapter 1
	L06	February 1, 2017 (Wed)	Chapter 1, Assignment 2
	L07	February 3, 2017 (Fri)	Chapter 1, **Quiz 1**
Part II: Continuous-time option pricing models			
4	L08	February 6, 2017 (Mon)	Chapter 1
	L09	February 8, 2017 (Wed)	Chapter 1, Assignment 3
	L10	February 10, 2017 (Fri)	Chapter 2
5	L11	February 13, 2017 (Mon)	Chapter 2
	L12	February 15, 2017 (Wed)	Chapter 3, Assignment 4
	L13	February 17, 2017 (Fri)	Chapter 3, **Quiz 2**
6	L14	February 20, 2017 (Mon)	Chapter 3
	L15	February 22, 2017 (Wed)	Chapter 3, Assignment 5
	L16	February 24, 2017 (Fri)	Chapter 3
7	L17	February 27, 2017 (Mon)	Chapter 3
	L18	March 1, 2017 (Wed)	Chapter 4, Assignment 6
	L19	March 3, 2017 (Fri)	Chapter 4, **Quiz 3**

[ii] Refer to the numbering in the lecture notes, not McDonald (2013).

8	L20	March 6, 2017 (Mon)	Chapter 4
	L21	March 8, 2017 (Wed)	Chapter 5, Assignment 7
	L22	March 10, 2017 (Fri)	Chapter 5
—	—	March 13, 2017 (Mon)	(Spring Break - No class!)
	—	March 15, 2017 (Wed)	
	—	March 17, 2017 (Fri)	
9	L23	March 20, 2017 (Mon)	Chapter 5
	L24	March 22, 2017 (Wed)	Chapter 5, Assignment 8
	L25	March 24, 2017 (Fri)	Chapter 5, **Quiz 4**
10	L26	March 27, 2017 (Mon)	Chapter 5
	—	March 29, 2017 (Wed)	**(No class. Midterm in evening!)**
	L27	March 31, 2017 (Fri)	Chapter 5
11	L28	April 3, 2017 (Mon)[iii]	Chapter 6
	L29	April 5, 2017 (Wed)	Chapter 6, Assignment 9
	L30	April 7, 2017 (Fri)	Chapter 6
Part III: Interest rate derivatives			
12	L31	April 10, 2017 (Mon)	Chapter 7
	L32	April 12, 2017 (Wed)	Chapter 7, Assignment 10
	L33	April 14, 2017 (Fri)	Chapter 8, **Quiz 5**
Part IV: Epilogue: General properties of option prices			
13	L34	April 17, 2017 (Mon)	Chapter 8
	L35	April 19, 2017 (Wed)	Chapter 9, Assignment 11
	L36	April 21, 2017 (Fri)	Chapter 9
14	L37	April 24, 2017 (Mon)	Chapter 9
	L38	April 26, 2017 (Wed)	Chapter 9, Assignment 12
	L39	April 28, 2017 (Fri)	Chapter 9, **Quiz 6**
15	L40	May 1, 2017 (Mon)	Appendix
	L41	May 3, 2017 (Wed)	Appendix
	L42	May 5, 2017 (Fri)	Appendix / Final Review

[iii] Drop date for undergraduate students (This course is also offered in Fall 2017 for those who wish to retake it ☻)

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*, *Scandinavian Actuarial Journal* and *ASTIN Bulletin: The Journal of the International Actuarial Association*.

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 the 1222-page ACTEX CAS Exam S Study Manual (Spring 2017 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 correspondences (Operations Manual, III.15.2, 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 includes but is 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 Office of the Sexual Misconduct Response Coordinator for 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****