ACTS:4380
Mathematics of Finance II
Course Syllabus
Fall 2017

THE UNIVERSITY OF IOWA

CAE Center of Actuarial Excellence
SOCIETY OF ACTUARIES
University of Iowa

Aug 21, 2017 – Nov 3, 2017∗
MWThF, 71 SH
3:30 p.m. – 4:20 p.m.

COLLEGE OF LIBERAL ARTS & SCIENCES

Department of Statistics & Actuarial Science

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Department of Statistics and
Actuarial Science

∗ This is an off-cycle course lasting for 11 weeks only. The drop date is October 12, 2017.

1 Contact Information

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  (Note: Please put "ACTS:4380" in the subject line)

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  (This page is mainly about my research endeavors. Feel free to visit it from time to time!)

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2 Course Description and Objectives

Building upon the conceptual foundation on financial derivatives developed in the second part of the Society of Actuaries (SOA) (pre-June 2017) 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. 2 weeks)
Part II.	Continuous-time option pricing models	(approx. 7 weeks)
Part III.	Interest rate derivatives	(approx. 1 week)
Part IV.	Epilogue: General properties of option prices	(approx. 1 week)

The central theme of the course is to determine the fair price of a financial derivative in the context of different pricing models. Together with the one-study-hour exam preparation course ACTS:4160 (see Section 4), the course fully covers the syllabus of the November 2017 Exam MFE. After taking this course, the successful student is expected to:

1. Understand the mechanics of different kinds of financial derivatives.

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

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

4. Take and, most importantly, pass Exam MFE in November 2017 with considerable ease.

5. (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, each of which includes 5 answer choices identified by A, B, C, D, and E. Historically, the pass mark was approximately **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), 60 sample questions on introductory derivatives, and 40 sample questions on advanced derivatives, all 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 Fall 2017, Exam MFE will be offered via computer-based testing (CBT) from **November 16 to November 22**. The registration deadline is October 10 (please refer to `https://www.soa.org/Education/Exam-Req/Exam-Day-Info/edu-2017-cbt-test-schedule.aspx`). It is strongly suggested that you take the exam in November as you learn the material, do the homework, and study for the quizzes and exams in this course (strike while the iron is hot!). In fact, the off-cycle arrangement of the course is made so that it will end well before you take the November MFE exam. In the "unlikely" event that you cannot pass the exam in November, you should retake it in March 2018, the very last time that Exam MFE is offered.

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[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 at least 21 correct.

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.

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 may have learnt from the second part of the pre-June 2017 Exam FM (or the one-study-hour prep. course ACTS:3210/4160/6160) is now shifted to Exam MFE. Meanwhile, some hard topics in the old MFE syllabus have been deleted *(hurray!)*.

4 ACTS:4160 Actuarial Exam MFE Preparation

Due to the importance of passing Exam MFE before the new SOA exam system is put in place in July 2018, the Department of Statistics and Actuarial Science has, for the first time, created the exam preparation course ACTS:4160 *Topics in Actuarial Science - Actuarial Exam MFE Preparation* (1 s.h.) specifically designed for the MFE exam. Just like ACTS:4380, the exam preparation course will be offered in an off-cycle manner, with one meeting (Tuesday, 3:30 pm – 4:40 pm, E246 AJB) per week for the first 11 weeks of the fall semester. The functions of the prep course are two-fold:

1. While my ACTS:4380 lectures will mainly focus on concepts in the MFE syllabus, in the prep. course you will be given ample opportunities to work out problems based on the concepts taught in class. These problems include past MFE exam problems, past ACTS:4380 exam problems, and/or original practice problems. Needless to say, practice makes perfect, especially on actuarial exams. For each class, we plan to assign a classwork question, which you will be given some time to attempt in class and submit for grading. We want to know how well (or poorly!) you do.

2. The prep. course will also review concepts I taught in class and occasionally introduce concepts which I have no time to go over.

Taking ACTS:4160 together with ACTS:4380 will create synergy that will improve your grade in ACTS:4380 and, more importantly, increase your likelihood of passing MFE in November 2017. There is no need to worry about the grading in the prep. course, since everyone will be assessed on a pass/fail basis. As long as you attend the prep. course regularly and complete the classwork satisfactorily (we do not expect a perfect solution), you will be able to pass the course.

5 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 optional text for this course is

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

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

6 Grading System

Assessment in this course comprises the following items:

1. **Attendance and attitude:** $\pm\varepsilon\%$[ii]

   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 or inquire about any announcements made in class. Likewise, your participation, preparedness, and work ethic may affect your final grade (positively or negatively).

2. **Assignments: 20%**

   There will be weekly assignments consisting of 4 to 5 end-of-chapter problems in the lecture notes, usually assigned on Wednesday and due the next Wednesday. Any exceptions will be announced in class or in ICON. 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: 15%**

   There will be a total of five 15-minute quizzes held on Fridays. 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 two-hour written Midterm Examination to be held in the evening (6:30 p.m. – 8:30 p.m.) of **October 6, 2017 (Friday)** at 2217 SC testing the material in Chapters 1 to 7 of this course (with an emphasis on Chapters 4 to 7). It will consist mainly of a series of short computational questions similar in style to MFE problems and/or end-of-chapter 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 Final Examination will take place in the evening (6:30 p.m. – 8:30 p.m.) of **November 6, 2017 (Monday)** at 140 SH testing the material in the whole Exam MFE syllabus, with an emphasis on Chapters 8 to 12 of this course. As an immediate precursor of the November 2017 MFE Exam, the Final Exam serves as a mock exam and gives you a rough picture of how you will perform in the real exam. Like the Midterm Exam, it will comprise mainly short computational questions similar in style to MFE problems and/or end-of-chapter problems in the lecture notes.

[ii]In mathematics, ε usually denotes a small number.

All quizzes and exams in this course are closed-book and you are not allowed to bring your own formula sheet (the same applies to 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 grades will be given 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.

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 2018 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 6 hours outside of class meetings reviewing the course notes and working on the end-of-chapter problems independently. It is fine to work harder, but working less is risky. Let me know if you encounter any problems with your learning.

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7 Tentative Teaching, Assignment, and Quiz Schedule

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

(L: Lecture; E: Exam preparation class)

Week	Number	Date	Lecture Topic	Prep. Course Topic
Part I. Discrete-time Option Pricing Models				
1	L01	Aug 21, 2017 (Mon)	Chapter 4	—
	E01	Aug 22, 2017 (Tue)	—	Review: Chapters 1–2
	L02	Aug 23, 2017 (Wed)	Chapter 4	—
	L03	Aug 24, 2017 (Thur)	Chapter 4	—
	L04	Aug 25, 2017 (Fri)	Chapter 4, **Assignment 1**	—
2	L05	Aug 28, 2017 (Mon)	Chapter 4	—
	E02	Aug 29, 2017 (Tue)	—	Review: Chapters 2–3
	L06	Aug 30, 2017 (Wed)	Chapter 4, **Assignment 2**	—
	L07	Aug 31, 2017 (Thur)	Chapter 4	—
	L08	Sep 1, 2017 (Fri)	Chapter 4, **Quiz 1**	—
3	—	Sep 4, 2017 (Mon)	(University Holiday)	—
	E03	Sep 5, 2017 (Tue)	—	Review: Chapter 4
	L09	Sep 6, 2017 (Wed)	Chapter 4, **Assignment 3**	—
	L10	Sep 7, 2017 (Thur)	Chapter 5	—
	L11	Sep 8, 2017 (Fri)	Chapter 5, **Quiz 2**	—
Part II. Continuous-time Option Pricing Models				
4	L12	Sep 11, 2017 (Mon)	Chapter 5	—
	E04	Sep 12, 2017 (Tue)	—	Review: Chapter 5
	L13	Sep 13, 2017 (Wed)	Chapter 6, **Assignment 4**	—
	L14	Sep 14, 2017 (Thur)	Chapter 6	—
	L15	Sep 15, 2017 (Fri)	Chapter 6	—
5	L16	Sep 18, 2017 (Mon)	Chapter 6	—
	E05	Sep 19, 2017 (Tue)	—	Review: Chapter 6
	L17	Sep 20, 2017 (Wed)	Chapter 6, **Assignment 5**	—
	L18	Sep 21, 2017 (Thur)	Chapter 6	—
	L19	Sep 22, 2017 (Fri)	Chapter 7, **Quiz 3**	—
6	L20	Sep 25, 2017 (Mon)	Chapter 7	—
	E06	Sep 26, 2017 (Tue)	—	Review: Chapter 6
	L21	Sep 27, 2017 (Wed)	Chapter 7, **Assignment 6**	—
	L22	Sep 28, 2017 (Thur)	Chapter 7	—
	L23	Sep 29, 2017 (Fri)	Chapter 8	—
7	L24	Oct 2, 2017 (Mon)	Chapter 8	—
	E07	Oct 3, 2017 (Tue)	—	Review: Chapter 7
	—	Oct 4, 2017 (Wed)	(No class due to Actuarial Job Fair)	—
	L25	Oct 5, 2017 (Thur)	Chapter 8	—
	—	Oct 6, 2017 (Fri)	**(No class. Midterm in evening!)**	—
8	L26	Oct 9, 2017 (Mon)	Chapter 8	—
	E08	Oct 10, 2017 (Tue)	—	Review: Chapter 8

	L27	Oct 11, 2017 (Wed)	Chapter 8, **Assignment 7**	—
	L28	Oct 12, 2017 (Thur)	Chapter 8	—
	L29	Oct 13, 2017 (Fri)	Chapter 8	—
9	L30	Oct 16, 2017 (Mon)	Chapter 8	—
	E09	Oct 17, 2017 (Tue)	—	Review: Chapter 8
	L31	Oct 18, 2017 (Wed)	Chapter 9, **Assignment 8**	—
	L32	Oct 19, 2017 (Thur)	Chapter 9	—
	L33	Oct 20, 2017 (Fri)	Chapter 9, **Quiz 4**	—
Part III. Interest Rate Derivatives				
10	L34	Oct 23, 2017 (Mon)	Chapter 10	—
	E10	Oct 24, 2017 (Tue)	—	Chapter 12
	L35	Oct 25, 2017 (Wed)	Chapter 10, **Assignment 9**	—
	L36	Oct 26, 2017 (Thur)	Chapter 11	—
	L37	Oct 27, 2017 (Fri)	Chapter 11, **Quiz 5**	—
Part IV. Epilogue: General Properties of Option Prices				
11	L38	Oct 30, 2017 (Mon)	Chapter 12	—
	E11	Oct 31, 2017 (Tue)	—	Chapter 12
	L39	Nov 1, 2017 (Wed)	Chapter 12, **Assignment 10**	—
	L40	Nov 2, 2017 (Thur)	Final review	—
	L41	Nov 3, 2017 (Fri)	Final review	—
12	—	Nov 6, 2017 (Mon)	**Final Examination**	
—	—	Nov 16–22, 2017	**November 2017 Exam MFE**	

* Refer to the numbering in the lecture notes, not McDonald (2013)

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More about the instructor ("Shameless" self-introduction...)

Professor Ambrose Lo was born (in 19X9), raised, and educated in Hong Kong. He 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, advanced probability theory, and regression analysis. His emphasis in teaching is always placed on thorough understanding of the subject matter complemented by concrete problem-solving skills. He is also the sole author of the 1370-page ACTEX CAS Exam S Study Manual (Fall 2017 Edition).

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The College of Liberal Arts & Sciences:
Important 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.

Nondiscrimination in the Classroom

The University of Iowa is committed to making the classroom a respectful and inclusive space for all people irrespective of their gender, sexual, racial, religious or other identities. Toward this goal, students are invited to optionally share their preferred names and pronouns with their instructors and classmates. The University of Iowa prohibits discrimination and harassment against individuals on the basis of race, class, gender, sexual orientation, national origin, and other identity categories set forth in the University's Human Rights policy. For more information, contact the Office of Equal Opportunity and Diversity, `diversity@iowa.edu` or visit `diversity.uiowa.edu`.

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