Math 440 Mathematical Theory of Financial Economics
Bouillon 210, 8:00 – 8:50 (M-F)

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Office Hours: M,W 1:30-2:30; Tu,Th 11-11:50; and appointment.
Students are welcome to come in anytime when I am in my
office. Check out http://www.cwu.edu/~chueh or calendar on my office
door for my daily schedule.

Prerequisite: MATH 411B and 418C.

Text: Derivatives Markets, 3nd Edition, 2013, Robert L. McDonald, Pearson
Actex MFE Study Manual, Johnny Li, Actex, Spring 2015 Edition

Course Objectives:

This 5-credit one-quarter course is offered to cover the syllabus from Exam MFE Models for Financial Economics. It comes alongside students to help them prepare for this challenging and advanced professional exam. Given the large amount of material and topics to cover and practice thoroughly before our bi-weekly quiz assessments, students will assume the largest responsibility of reading the textbooks regularly. It's advised that students taking this course have their diligent reading before and after our daily lectures, discussions, and problem solving training.

The Models for Financial Economics (MFE) Exam is a three hour multiple-choice examination. Exam MFE is offered via computer-based testing (CBT). It is called Exam MFE by the Society of Actuaries and Exam 3F by the CAS.

The syllabus for Exam MFE develops the candidate's **knowledge of the theoretical basis of certain actuarial models and the application of those models to insurance and other financial risks**. A thorough knowledge of calculus, probability and interest theory is assumed. Knowledge of risk management at the level of Exam 1/P is also assumed. In addition, for Exam MFE/3F, **candidates are assumed to be familiar with the earlier chapters of the McDonald text, which are in the syllabus of Exam 2/FM**.

LEARNING OUTCOMES – MODELS FOR FINANCIAL ECONOMICS
A. Interest rate models (10-15%)

1. Evaluate features of the Vasicek and Cox-Ingersoll-Ross bond price models.
2. Explain why the time-zero yield curve in the Vasicek and Cox-Ingersoll-Ross bond price models cannot be exogenously prescribed.
3. Construct a Black-Derman-Toy binomial model matching a given time-zero yield curve and a set of volatilities.

B. Rational valuation of derivative securities (65-75%)

1. Use put-call parity to determine the relationship between prices of European put and call options and to identify arbitrage opportunities.
2. Calculate the value of European and American options using the binomial model.
3. Calculate the value of European options using the Black-Scholes option-pricing model.
4. Identify the situations where the values of European and American options are the same.
5. Interpret the option Greeks.
6. Explain the cash flow characteristics of the following exotic options: Asian, barrier, compound, gap, and exchange.
7. Explain the properties of a lognormal distribution and explain the Black-Scholes formula as an expected value for a lognormal distribution.
8. Explain what it means to say that stock prices follow a diffusion process.
9. Apply Itô's lemma in the one-dimensional case.

C. Simulation (10-15%)

1. Simulate lognormal stock prices.
2. Use variance reduction techniques to accelerate convergence.

D. Risk management techniques (5-10%)

1. Explain and demonstrate how to control risk using the method of delta-hedging.
Note: Concepts, principles and techniques needed for Exam MFE/3F are covered in the reference listed below. Candidates and professional educators may use other references, but candidates should be very familiar with the notation and terminology used in the listed references.

Texts – Models for Financial Economics*
Derivatives Markets (Third Edition), 2013, by McDonald, R.L., Pearson Education,
ISBN: 978-0-32154-308-0
Chapter 9,
Chapter 10, (excluding "Options on Commodities" on pages 315 and 316),
Chapter 11, Sections 11.1–11.3, Appendices 11.A and 11.B,
Chapter 12, Sections 12.1–12.5, Appendix 12.A,
Chapter 13, including Appendix 13.B,
Chapter 14, Chapter 18,
Chapter 19, Sections 19.1–19.5,
Chapter 20, 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 SaQb on pages 621-622)
Chapter 21, 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, Section 23.1 (but with only those definitions in Tables 23.1 and 23.2 that are relevant to Section 23.1),
Chapter 24, 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, 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),

Appendix B.1, Appendix C.
Unless otherwise stated chapter appendices are not included in the required readings from this text.

Other Resources – Models for Financial Economics

http://www.soa.org/files/pdf/edu-2009-fall-mfe-table.pdf

Formulas and Tables for CBT:
A normal distribution calculator will be available during the test by clicking buttons on the item screen.
http://www.prometric.com/SOA/MFE3F_calculator.htm

Formula document
http://www.soa.org/files/edu/edu-exam-mfe-formula-doc.pdf

Some Remarks on *Derivatives Markets*
http://www.soa.org/files/edu/edu-2014-07-mfe-remarks.pdf

All released exam papers, since 2000 can be found here.
http://www.soa.org/education/exam-req/syllabus-study-materials/edu-multiple-choice-exam.aspx

Exam MFE Sample Questions and Solutions (1-76)

http://www.soa.org/files/edu/edu-exam-mfe-sample-quest-sol.pdf

We will use McDonald's Derivatives Markets for general reading to develop your knowledge of the definitions and applications of financial derivatives and their valuation models. However, the exercises and problem sets in this text are either too easy or too hard in computations (with incorrect answers sometimes) for SOA/CAS MFE exam. To more effectively use your time and get early exposure to the exam-style problems, we will use Actex MFE/3F study manual 2015 edition throughout this course. This manual is the only supplemental textbook needed in additional to the official McDonald's for the purpose of taking SOA MFE exam. For advanced students, feel free to use McDonald's as a reference/introduction and focus on the reading of the self-contained Actex manual.

My plan is to have the class read the assigned chapter sections from McDonald **before** each class period and review your reading by slides presentations at home. Students are urged to comment on the slides and raise questions by email and in class. A great portion of class time will be devoted to go over in-detail technical and conceptual notes (following Actex manual) for exam problem solving purpose.

My test questions will be similar to the homework problems and perhaps problems drawn from the following sample question bank. However, students shouldn't memorize these problems and solutions without developing adequate knowledge and skills to apply to problem solving.

Sample questions Posted at http://www.cwu.edu/~chueh/Math440.htm

Class format

Lecture followed by problem solving and group work. Instructor and students discuss their solutions of the assigned problems and answer questions raised by the instructor and the class. This is a very fast-paced class so be sure that you follow our schedule consistently by reading and coming to the class every day.

Attendance

To achieve success in *any* mathematics class, **regular attendance is almost imperative**. Unlike most subjects, new topics in Mathematical Theory of Financial Economics often build on previous knowledge; failure to learn something early may haunt you throughout the course. We will do work in class occasionally, so if you missed a class you missed in-class credit.

IF YOU MISS CLASS, IT IS YOUR RESPONSIBILITY TO FIND OUT THE MATERIAL COVERED, MEMORABLE, OR ASSIGNED, AND TO ARRANGE TO PICK UP ANY ASSIGNMENTS THAT MAY BE HANDED OUT OR RETURNED!

Homework

Homework will be assigned in class and the due date will be every Friday. Working on homework is the only way most of us learn to critically analyze and "solve" problems.

Some class time will be devoted to questions on the homework. Office hours are also scheduled to provide opportunities for more in-depth discussion and solving of homework problems.

Grading policy

➢ Assignments (100 points)
  In-class problem solving/presentation   (50 points)
➢ Five Quizzes   (250 points)
➢ Final Exam   (100 points)
   Total   500 points

Weekly Schedule (Any change of coverage and quiz schedule will be announced in class.)

Week	**Reading Assignment**
0. 9/23-9/25	Sections from McDonald's 1.4, 5.2(page 132 only) 5.1-5.3, 2.2, 9.1 10.1-10.5, 11.2, 11.3, 11.B
1. 9/28-10/2	Risk-Neutral Valuation in Discrete Time Actex Module 0 and Module 1
2. 10/5-10/9	Review; **Quiz 1 Friday**
3. 10/12-10/16	Sections from McDonald's 11.3, 12.1, 18.1-18.4, 20.1-20.20.7(skip backward equation, lease Rate, valuing a claim, multivariate Ito's lemma) Risk-Neutral Valuation in Continuous Time Actex Module 2
4. 10/19-10/23	Review; **Quiz 2 Friday**
5. 10/26-10/30	Sections from McDonald's 11.4, 12.1-12.3, 12.5, 13.B, 13.2-13.5, 18.5, 18.6, 22.1, 23.1, 23.2 The Black-Scholes Formula Actex Module 3
6. 11/2-11/6	Review; **Quiz 3 Friday**
7. 11/9-11/13	Sections from McDonald's 9.2, 9.3, 14.2-14.6, 19.2-19.5 Further Topics on Option Pricing Actex Module 4
8. 11/16-11/20	Review; **Quiz 4 Friday**
9. 11/23- 11/27	Sections from McDonald's 9.1,12.2, 24.1-24.5(Skip forward rate agreements) Interest Rate Models Actex Module 5

THANKSGIVING!!

10. 11/30-12/4   Review; **Quiz 5 Friday**

11. 12/7-12/11   **Final Exam, accumulative Quiz 1-Quiz 5**