COURSE NAME:

Mathematics 573/673 - Actuarial Models I

PREREQUISITES: MATH 570, MATH 572.
The class is offered on both undergraduate (573) and graduate level (673).

This course covers the material for the **Society of Actuaries Exam MFE, Actuarial Models-Financial Economics** (also CAS Exam 3F).
The syllabus for Exam MFE develops the candidate's knowledge of the theoretical basis of financial 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.

Texts – Models for Financial Economics

Derivatives Markets (Third Edition), 2013, by McDonald, R.L.,
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 S^aQ^b 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/McDo nald-web-25-A.pdf),
Appendix B.1, Appendix C.
Unless otherwise stated chapter appendices are not included in the required readings from this text.