

COURSE NAME:

Mathematics 574/674 - Actuarial Models II

PREREQUISITES: MATH 570, MATH 572.

The class is offered on both undergraduate (574) and graduate level (674).

COURSE DESCRIPTION:

This is the second course in the two semester sequence: Math 573/673 - Math 574/. This course covers the material for the **Society of Actuaries Exam MLC, Actuarial Models, Life Contingencies**: Poisson Processes and Markov Processes and the material for the **Society of Actuaries Exam MFE, Financial Economics**.

LEARNING OUTCOMES – LIFE CONTINGENCIES SEGMENT

B. Markov Chain Models

1. Define non-homogeneous and homogeneous discrete-time Markov Chain models and calculate the probabilities of
 - a) being in a particular state;
 - b) transitioning between particular states.

C. Life insurances and annuities

7. Extend the present-value-of-benefit, present-value-of-loss-at-issue, present-value-of-future-loss random variables and liabilities to discrete-time Markov Chain models, to calculate
 - a) actuarial present values of cash flows at transitions between states;
 - b) actuarial present values of cash flows while in a state;
 - c) considerations (premiums) using the Equivalence Principle;
 - d) liabilities (reserves) using the prospective method.

D. Poisson processes

1. Define Poisson process and compound Poisson process.
2. Define and calculate expected values, variances, and probabilities for Poisson processes,
 - a) using increments in the homogeneous case;
 - b) using interevent times in the homogeneous case;
 - c) using increments in the non-homogeneous case.

LEARNING OUTCOMES – FINANCIAL ECONOMICS SEGMENT

A. Interest rate models

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

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 and American options using the Black-Scholes option-pricing model.
4. Interpret the option Greeks.
5. Explain the cash flow characteristics of the following exotic options: Asian, barrier, compound, gap, and exchange.
6. Explain what it means to say that stock prices follow a diffusion process.
7. Apply Itô's lemma in the one-dimensional case.
8. Apply option pricing concepts to actuarial problems such as equity-linked insurance.

C. Risk management techniques

1. Explain and demonstrate how to control risk using the method of delta-hedging.

Texts – Financial Economics Segment *

- # *Derivatives Markets* (Second Edition), 2006, by McDonald, R.L., Chapters 9-11, 12.1–12.5, 13, 14 (excluding appendices), 20.1–20.6 (through “Functions of an Itô Process”), 20.7 (up to but excluding the last subsection on “Valuing a Claim on $S^{\mathbb{Q}}$ ”), 24.1–24.5 (up to but excluding “Forward rate agreements”), (including Errata, see below).

*Any textbook errata are included in the Introductory Study Note.

Study Notes - Financial Economics Segment

Code	Title
MFE-05-08#	Exam MFE Introductory Study Note Exam MFE Tables Some Remarks on <i>Derivatives Markets</i> <i>Derivatives Markets, Errata</i> 2006 Second Edition, first printing by R. McDonald, http://www.kellogg.northwestern.edu/faculty/mcdonald/hm/typos2e_01.html
Past Exams	All released exam papers , since 2000 can be found here.
MFE-09-07	Exam MFE Sample Questions and Solutions