Department of Statistical & Actuarial Sciences
The University of Western Ontario
London, Ontario, Canada

STATISTICAL SCIENCES 3520B
Financial Modelling I
Winter 2014

Instructor: Dr Rogemar S Mamon
Office: WSC 209
Phone: 519-661-2111 ext 83625
E-mail: rmamon@stats.uwo.ca

Course Website: Announcements and certain course materials will be posted in the course website. You can find the URL link from this address:
http://www.stats.uwo.ca/faculty/rmamon
Username: **ss3520bw14** Password: **CRR1979jfe**

Please visit the site before coming to the lecture.

Office Hours: 10:45 – 11:45 Mon, Wed and Fri

Send a brief email stating your intent to make an appointment, the nature of queries and the time you're dropping by.

Lectures: Monday, Wednesday and Friday 13:30-14:20 in WSC 240.

Prerequisites: A minimum mark of 60% in both Actuarial Science 2557A/B and Statistical Sciences 2857A/B.

If you do not have the above prerequisites, you may enroll by **special permission.**

Remark: This course complements AM 3613B, which is typically a PDE-based course. This course employs a probabilistic approach.

Description: Discrete-time market models, option pricing and replication, risk-neutral valuation and martingale measures, and the fundamental theorem of asset pricing. Discrete-time Black-Scholes. Value-at-risk, mean-variance portfolio analysis, capital asset pricing model. Discrete-time interest rate models. Duration, convexity and immunization. Simulation.

Main Text: Jaksa Cvitanic and Fernando Zapatero (2004). *Introduction to the Economics and Mathematics of Financial Markets*. MIT Press, Cambridge, Massachusetts. **[JCFZ]**

John Hull (2012). *Options, Futures, and Other Derivatives*, 8th edition. Pearson Prentice Hall. **[JH]**

Weekly summary of lectures will be provided by the instructor in the course website.

Midterm tests: Two 2-hour tests will be given in class on **28 February 2014** (Friday) and **21 March 2014** (Friday). Venue: TBA
Time: 07-09PM.

Evaluation: Students will be assessed on the basis of 3 assignments (20%) 2 midterms (40%) and a 3-hour sit-in final examination (40%). The assessment is **fixed** since this course can be used (in combination with SS 4521G) to get exemption in the CIA exam, provided an individual mark of 80% or better is obtained.

Assignments: There will be three assignments in this course to be given every 3-4 weeks. Each assignment will be posted in the course website one week before the due date. These due dates are: ***07 February 2014*** for Assignment #1; ***12 March 2014*** for Assignment #2; and ***04 April 2014*** for Assignment #3. **Submit your assignments in class on the due date**. **Under no circumstances will late assignments be accepted.**

Final Exam: To be scheduled by the Registrar's office and will be held in April 2014.

Missed Assignments and Midterm tests:	**<u>There will be no make-up for missed assignments and midterm exams</u>.** For those who are unable to hand in an assignment or write an exam, the standard practice will be that the weight of the missed course requirement will be transferred to the final exam. Supporting documentation must be provided.
Info for Audit Students:	If you are auditing this course, you must submit ALL assignments and obtain an average assignment mark of 70% or above to have the AUDIT reflected in your transcript. Audit students are NOT required to write the final exam. If you are an AUDIT student, you have the option not to submit assignments but write the final exam instead and must obtain a mark of 70%. Otherwise, an audit mark cannot be granted.

VERY IMPORTANT: Students in this course must read carefully the course outline and ensure they read the sections on:

(i) Student's responsibility when unable to submit assignments of write the final exam due to illness or other extenuating circumstances.

(ii) E-mail policy to set-up an appointment or clarifying assignment questions requiring only brief responses.

(iii) Plagiarism – what constitute plagiarism and possible penalties.

(iv) Mutual expectations of students and instructor

Statistical Sciences 3520B
(Winter 2014)
Specific topics to be covered with relevant readings

❖ Brief Review: (i) derivatives and how they are used by different types of traders. **Relevant readings:** Sections 1.3 and 1.4 of JCFZ and Chapter 1 of JH; (ii) Determination of forward and futures prices (To demonstrate no-arbitrage pricing principle). **Relevant readings:** Section 6.2 of JCFZ and Chapter 5 of JH.

❖Elements of stochastic processes in discrete time. This topic is based on instructor's notes.

❖Discrete-time market models, option pricing by replication, risk-neutral valuation and martingale measures, and the fundamental theorem of asset pricing. Discrete-time Black-Scholes pricing framework (the Cox-Ross-Rubinstein binomial option pricing model). **Relevant readings:** Sections 3.1-3.2, 6.3.1-6.3.5 of JCFZ and Chapter 12 of JH.

❖ Value-at-risk. **Relevant readings:** Section 5.2 of JCFZ and Chapter 21 of JH.

❖ Discrete-time interest rate models: Concepts of equilibrium and no-arbitrage models, trinomial trees (if time permits). **Relevant readings:** Chapter of JH.

The End of Course Outline

Purpose of Financial Modelling I

- Intro to important concepts in pricing derivative securities
- Provide quantitative tools to quantify market risk
- Valuation and risk management of fixed income instruments
- Study fundamental principles in investments
  - -- Mean-variance analysis for asset allocation
  - -- Capital asset pricing model
- Prepare students for the necessary concepts needed for the treatment of asset pricing in continuous time (SS 4521)

The nature of this course

- Is this course challenging?

YES and NO

Your main focus should be on:

Intuition behind the simple mathematics, understanding model assumptions, learning recent innovations and fundamental theories that form the underpinnings in financial valuation and risk management. Elements of stochastic processes in discrete-time will be introduced.

Revisit <u>briefly</u> the following (**AS 2557 refresher**):

- The role of derivatives: why do they exist?
- How are derivatives employed by arbitrageurs, hedgers and speculators?
- How does one determine prices for forwards and futures?

Note: *It is assumed that everyone knows properties of stock options.*

New Developments

Foreign exchange

- Freeing of exchange and capital controls in the past 3 decades (more FX trades)
- Need to eliminate FX risk

Interest rate

- Interest rate controls were eliminated and coincided with increases in government budget deficits
- Large new issues of government debts in almost all industrialised nations

So, what contributed mainly to the prolific increase in markets for derivative products?

How was the need to hedge or control the risk associated with FX and interest rate uncertainty addressed?

It was addressed by the market partly through ….

- Conceptual understanding of the ***structure, functioning and pricing*** of these derivative products is paramount.

- Theoretical valuation models are directly applicable to these new products.

- Important question: *How does a financial institution (FI) "price correctly" a financial instrument that is not even trading yet in the market?*

Introduction of new products become easier and less costly.

- New exchanges and market places came into being in response to the growth of derivative securities.

- Deregulation of financial services in the 1980's.

Theoretical developments covered in the pricing of derivatives

- ARBITRAGE THEOREM
- BLACK-SCHOLES MODEL (Black & Scholes, 1973). We shall consider the discrete-time version **[Cox-Ross-Rubinstein (CRR), 1979]**. Results published in the Journal of Financial Economics (JFE)
- METHODOLOGY OF EQUIVALENT MARTINGALE MEASURE

Important concepts to be emphasised in derivative valuation

- No-arbitrage pricing
- Risk-neutral probabilities
- Martingales

Concepts, ideas and theories in this course formed the very foundation of finance

Evidence: Ideas and theories recognised by the Nobel Memorial Prize for contributions in Economic Sciences

- Method to determine the price of derivatives (Scholes and Merton, 1997)
- Portfolio theory and diversification (Markowitz, 1990)
- Investment performance analysis (Sharpe, 1990)

Review of derivatives

Practitioner's definition: Derivative securities are financial contracts that "derive" their value from cash market instruments such as stocks, bonds, currencies and commodities.

Academic definition: A financial contract is a derivative security, or a contingent claim, if its value at expiration date T is determined exactly by the market price of the underlying cash instrument at at time T.

Caveat: The underlying financial variable does not necessarily have to be asset price.

Financial contracts are written on interest rates, inflation, temperature at a particular pt of a city, level of snow of a certain ski resort, or even the performance of a hockey team.

Note that since movement of financial variables, economic indicators, weather-related measurements or winning of sports are full of uncertainty. **This is where knowledge of probability and stochastic processes will come into the picture.**

Give an example of a derivative that you have so far studied in previous actuarial science courses.

Notation:

F:=price of a derivative security

$F(S_T)$:=value of derivative at time T; S is the underlying asset and T is the maturity date

$F(S_t, t)$: = price of a derivative product written on the underlying asset S_t at time t.

Types of derivatives

Three general classification

- Futures and forwards
- Options
- Swaps

Basic building blocks: (i) forwards and (ii) options

Others are hybrid securities.

Main Groups of Underlying Asset/Variables

- ***Stocks***
- ***Currencies***
- ***Interests***
- ***Indices***
- ***Commodities***