UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

BUSINESS SCHOOL
Te Kura Pakihi

COURSE OUTLINE

FINC 405
Mathematical Finance

Semester Two, 2021

This course outline contains information specific to this paper. For more general information common to your papers, please refer to the COMMERCE_UG_2018: Commerce Undergraduate Students site on Blackboard.

Paper Description and Aims

This paper provides students with the necessary mathematical techniques used in continuous-time finance. It covers stochastic calculus, partial differential equation and applied probability. After taking this course, one should be able to fully understand no-arbitrage theory, Black-Scholes equation, risk-neutral probability and martingale. The purpose of this course is to lay down a solid mathematical foundation for students to learn more advanced topics in financial engineering, such exotic options, interest rate derivatives and credit risk models.

Prerequisite: Knowledge on Derivatives Securities and Advanced Calculus are required.

Learning Outcomes

Upon successful completion of this paper, you should be able to:

1. Understand the concept of Brownian motion, expectations and martingale
2. Learn how to model stock and option prices and to derive the Black-Scholes equation for option price by using no-arbitrage principle
3. Understand the concept of Poisson process and learn Merton jump diffusion option pricing model
4. Learn Heston stochastic volatility model for option price

Teaching Staff

Paper Coordinator and Lecturer

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Tutor

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You should contact Pakorn (Beam) Aschakulporn with any administrative enquiries about the paper, e.g. tutorial changes, or requests for late submission of assignments.

Class Representatives

Class representatives are an important means of communication between students and staff. Contact details for your student class representatives can be found on the Blackboard page for this paper.

Course Delivery

Lecture Day/Time: Tue @ 12:00-13:50; Thu @ 12:00-13:50 Weeks: 28-34,36-41
Room: BURN6 on Tue; OBSG17 on Thu
Tutorials Day/Time: TBD

Every week students must attend four 50 minute lectures.

Lectures present the key conceptual material through discussion and interaction between teaching staff and students. Lectures are supported by readings.

In-class **exercises** posted from time to time during the lecture are designed for students to practice immediately the new concepts and skills. Active participations in discussion are expected for all students.

Assigned **homework** will review the concepts and skills delivered in the lectures and offer opportunity of self-examining of the strengths and weaknesses of the class learning.

The **Course Calendar** (in this outline) details scheduling information. Note that this calendar may change as the course proceeds. Any changes will be announced at lectures and be detailed on the course page.

Course Learning Resources

My teaching will mainly follow my own lecture notes. Soft copies of lecture notes will be available on the course page for you to download. There is no required textbook, but students will find the following reference books useful:

1. Cerny, Ales, 2009, *Mathematical Techniques in Finance: Tools for Incomplete Markets*, Princeton University Press.
2. McDonald, Robert L., 2013, *Derivatives Markets*, 3rd edition, Pearson.

The first book contains in-depth mathematical analysis of derivative pricing theory. The second book contains option pricing theory with more emphasis on application in the derivatives market.

Blackboard

https://blackboard.otago.ac.nz/ provides you with access to course materials, class notices, and resources. Blackboard is used to email the whole class so it is important that you check your student email and *Blackboard* regularly.

Further information about student support, learning support and information, academic integrity and other University resources for students is available on the COMMERCE_UG_2017: Commerce Undergraduate Students site on Blackboard.

Student Webmail

We will use your student email account to email you information relevant to your programme. To forward your University email address to an email address that you use regularly:

1. Log into your Student Mail account (http://www.otago.ac.nz/smlanding/) using your student username and password.
2. Click the **Cog** button (top right corner).
3. Click on **Mail** under **Your App Settings**.
4. Under **Accounts** on left hand side, select **Forwarding**.
5. Under the Forwarding heading, type in the email address you want your email to be forwarded to. You can also choose to have a copy of these emails kept on your StudentMail account, so please check the box if you would like this.
6. Click the **Save** button.

Assessment

All material presented is examinable (except where stated otherwise) by assignments and the final examination. All-important assessment information such as due dates and times, content, guidelines and so on will be discussed at lectures and, where appropriate, detailed on Blackboard. *Students are responsible for ensuring that they are aware of this information, keeping track of their own progress, and catching up on any missed classes.*

Assessment	% of final grade
Individual class contribution	10
Four assignments	30
Midterm exam	20
Final exam	40

Course Requirements

Attendance and In-class Participation

The material of this paper is highly sequential. To ensure that students gain the maximum benefit from classes, students are required to attend each lecture and tutorial. Attendance will be checked in each tutorial and randomly in lectures. ***Students are required to attend at least 70% of classes of this paper; otherwise they may be treated as having failed the whole course***. Attendance will be considered in assigning points for the individual class contribution.

In addition to attendance, in-class exercise will be posted from time to time during the lecture and/or tutorial. Credits will be awarded to those who provide directly related comments and suggestions. Students should also prepare to be called upon for input to solving the problems.

Assignments

I plan to give **four assignments**. You are required to work on them individually. Discussion among classmates is allowed. Please turn in your solutions on the due date. Late turn-in will be heavily discounted. Remember to put your names and student IDs on the first page of your manuscripts.

Midterm Exam

The **midterm exam** will be in class on **26 Aug 2021 (Thu)**. It will be a *closed* exam.

The Comprehensive Final Examination

A **three-hour final examination** will be comprehensive of all course topics and materials. It will be a *closed* exam given according to the semester schedule. No make-up examination will be given unless the student consults with the instructor prior to the scheduled date of the examination and provides documents to support the reason for missing the scheduled examination.

Learning Outcomes

Learning Outcome	Assessment	Assessment	Assessment	Exam	Total
Understand the concept of Brownian motion, expectations and martingale	In-class exercises	Assignment 1 and 2	Midterm exam	Final exam	40%
Learn how to model stock and option prices and to derive the Black-Scholes equation for option price by using no-arbitrage principle	In-class exercises		Midterm exam	Final exam	25%
Understand the concept of Poisson process and learn Merton jump diffusion option pricing model	In-class exercises	Assignment 3		Final exam	20%
Learn Heston stochastic volatility model for option price	In-class exercises	Assignment 4		Final exam	15%
Total	10%	30%	20%	40%	100%

Course Calendar

	Week Commencing	Topic	Reading	Notes
1	Monday 12 July	Brownian motion and normal distribution	Lecture note 1	
2	Monday 19 July	Probability density function of a function of Brownian motion	Lecture note 2	
3	Monday 26 July	Unconditional expectation of a function of a Brownian motion	Lecture note 3	Assignment 1 due 29 Jul
4	Monday 2 August	Conditional expectation of a Function of a Brownian motion and martingale	Lecture note 4	
5	Monday 9 August	Stock price model, Ito's Lemma and option price model	Lecture note 5	Assignment 2 due 12 Aug
6	Monday 16 August	No-arbitrage principle, forward price, put-call parity and the Black-Scholes model	Lecture note 6	
7	Monday 23 August	Midterm exam in class on 26 August		
Mid Semester Break 30 August – 3 September				
8	Monday 6 September	Poisson process	Lecture note 7	
9	Monday 13 September	Merton's jump diffusion model	Lecture note 8	
10	Monday 20 September	Mean-reverting process	Lecture note 9	Assignment 3 due 23 Sep
11	Monday 27 September	Heston model	Lecture note 10	
12	Monday 4 October	Applications		Assignment 4 due 7 Oct
13	Monday 11 October	Review		

Lectures End Friday 15 October 2021
University Exam Period 20 October – 13 November 2021

Disclaimer

While every effort is made to ensure that the information contained in this document is accurate, it is subject to change. Changes will be notified in class and via Blackboard. Students are encouraged to check Blackboard regularly. It is the student's responsibility to be informed.