UNSW SCIENCE

SCHOOL OF MATHS AND STATISTICS

MATH5975

INTRODUCTION TO STOCHASTIC ANALYSIS

Term 1, 2019

Cricos Provider Code: 00098G

MATH5975 – Course Outline

Information about the course

Course Authority: Dr. Libo Li
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Phone: 9385 7025

Consultation hours: TBA

Credit: This course counts for 6 Units of Credit (6UOC).

Lectures: There will be four hours of lectures per week and no official tutorials. However, potentially one of the lecture hours can be turned into a tutorial in the even weeks.

Weeks 1-5 and 7-9	Time	Location
Monday	19:00 - 21:00	Electrical Engineering G22
Wednesday	19:00 - 21:00	Red Centre Theatre
Week 10		
Wednesday	19:00 - 21:00	Red Centre Theatre
Week 11		
Monday	19:00 - 21:00	Electrical Engineering G22

Moodle: I will provide skeleton lecture notes on Moodle. It is expected that you take notes during the lecture time. Assignments, problems sets and announcements will be provided via Moodle.

Course aims

Modern theory of financial markets relies on advanced mathematical and statistical methods that are used to model, forecast and manage risk in complex financial transactions. After the publication in 1973 of the ground-breaking paper of Black and Scholes on the arbitrage pricing of European call options, it became clear that Stochastic Analysis is an indispensable tool for the theory of financial markets, derivation of prices of standard and exotic options and other derivative securities, hedging related financial risk, as well as managing the interest rate risk.

In this course, you will learn the basic concepts and techniques of Stochastic Analysis, such as: Brownian motion, martingales, Itô stochastic integral, Itô's formula, stochastic differential equations, equivalent change of a probability measure, integral representation of martingales with respect to a Brownian filtration, relations

to second order partial differential equations, the Feynman-Kac formula, and jump processes.

Some concepts will be illustrated by examples relevant for financial applications. However, the main goal of the course is to provide a necessary mathematical background for MATH5816 Continuous Time Financial Modelling and MATH5985 Term Structure Modelling, rather then to focus directly on financial concepts.

The course is a prerequisite for MATH5816 Continuous Time Financial Modelling and MATH5985 Term Structure Modelling and will provide a solid background for your Master Project as well.

Students taking this course will develop an appreciation of the basic problems of stochastic analysis and be able to

- Recognise which analysis procedure is appropriate for a given research problem
- Apply probability theory and stochastic analyis to practical problems
- Understand the usefulness of Stochastic Analysis in your professional area.

The ability to provide logical and coherent proofs of theoretic results, and the ability to solve problems via abstract methods will be paramount.

Through regularly attending lectures and applying themselves, students will develop competency in mathematical presentation, written and verbal skills.

New ideas and skills are introduced and demonstrated in lectures, then students develop these skills by applying them to specific tasks in assessments.

We believe that effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class by attending all classes if possible; reading through previous lecture notes, and reading additional textbooks on stochastic analysis; viewing the lectures as an opportunity to learn, rather than just copy down lecture notes; and having a genuine interest in the subject and making a serious effort to master the basic material.

The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular: research, inquiry and analytical thinking abilities, communication, and information literacy.

Assessment

UNSW assesses students under a standard based assessment policy. For how this policy is applied in the School of Mathematics and Statistics please see

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

Math 5975 assessment will consist of:

Assessment Task	Weight	Date
Assignment 1	5%	Week 4
Midterm Test	20 %	Week 7
Assignment 2	15 %	Week 10
Final Exam	60%	
Total	100 %	

For each assessment task, the main marking criteria will be clear and logical presentation of correct solutions.

Assignments

Rationale: Assignments will give an opportunity for students to try their hand at more difficult problems requiring more than one line of argument and also introduce them to aspects of the subject which are not explicitly covered in lectures.

Assignments must be your own work, or severe penalties will be incurred. For assignment two, you can work in groups up to 4 people. Hand in one copy of the solutions with all the names and student ID numbers on it.

Assignments must be handed in by the due date and time. Late submission will not be accepted unless there is documentary evidence of mitigating circumstances.

You should consult the University web page on plagiarism:
`https://student.unsw.edu.au/plagiarism`

Each assignment will be available as follows:

Assignment	Release Date	Due Date	Worth of your final mark
1	Week 2	Week 4	5 %
2	Week 8	Week 10	15 %

Midterm Test

Duration: 90 minutes

The midterm test will assess student mastery of the material covered in the lectures for the first half the course. The midterm test will take place in Week 7.

Weighting: 20% of your final mark

Further details about the midterm test will be available in class closer to the time.

Final Examination

Duration: Two hours
Please consult your *myunsw* for the time and place.

Rationale: The final examination will assess student mastery of the material covered in the lectures.

Weighting: 60% of your final mark.

Further details about the final examination will be available in class closer to the time.

Additional resources and support

Lecture Notes and Textbooks

I will provide skeleton lecture notes on moodle. This is a Masters course and it is expected that you take notes during the lecture time. If you miss a class, try to get the material from a fellow classmate.

Please read the first two chapters of Steve Shreve (2004) Stochastic Calculus for Finance II, Continuous Time Models, Springer for General Probability Theory (Chapter 1) and Information and Conditioning (Chapter 2) in the first week of class. It will help you understand the concepts that we will cover in the first week and the rest of the course.

Suggested Readings:

S. Shreve, Stochastic Calculus for Finance II, Continuous Time Models, Springer 2004.

M. Capiński and T. Zastawniak: *Mathematics for Finance: An Introduction to Financial Engineering.* Springer, 2003.

F. Klebaner: *Introduction to Stochastic Calculus with Applications.* Imperial College Press, 2005.

Thomas Mikosch: *Elementary Stochastic Calculus with Finance in View.* World Scientific, Singapore, 1999.

A. Etheridge: *A Course in Financial Calculus.* Cambridge University Press, 2002.

Robert J. Elliott and P.E. Kopp: *Mathematics of Financial Markets.* Springer, Berlin Heidelberg New York, 1999.

Damien Lamberton and Bernard Lapeyre: *Introduction to Stochastic Calculus Applied to Finance.* Chapman and Hall, London, 1996.

Ioannis Karatzas and Stephen Shreve: *Brownian Motion and Stochastic Calculus.* Springer, Berlin Heidelberg New York, 1988.

Bernt Øksendal : *Stochastic Differential Equations: An Introduction with Applications (Universitext)*, 6 edition, Springer, Berlin Heidelberg New York, 2010.

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. It is common practice to discuss informally with students how the course and their mastery of it are progressing.

Administrative matters

School Rules and Regulations

Fuller details of the general rules regarding attendance, release of marks, special consideration, etc., are available via the School of Mathematics and Statistics Web page at
`https://www.maths.unsw.edu.au/currentstudents/assessment-policies`.

Plagiarism and academic honesty

Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the university's policies on academic honesty and plagiarism can be found at `https://student.unsw.edu.au/plagiarism`.

Special Considerations

Please consult the School's webpage

`https://www.maths.unsw.edu.au/currentstudents/`

`special-consideration-illness-misadventure`

Proposed course schedule

Week	Topic
1	Basic Probability
1	Conditional Expectation
2	Stopping Times, Filtrations and Adapted Processes
2	Discrete Time Martingales
2	Standard Brownian Motion
3	Stopping Times and Martingales
3	Itô Stochastic Integral
4	Continuous Local Martingale, Continuous Semimartingales and Itô Processes
5	Itô's Formula
6	Lévy's Characterization Theorem
6	Martingale Representation Property
6	Stochastic Differential Equations
7	Strong Markov Property
7	Radon-Nikodým Density
7	Girsanov's Theorem
8	Martingale Measures
8 & 9	Other results on harmonic functions, Dirichlet Problem, Cauchy problem, etc
10	Feynman-Kac Formula