Faculty of Science
School of Mathematics & Statistics

MATH5965
Discrete Time Financial Modelling

Semester 1, 2017

MATH5965 – Course Outline

Information about the course

Course Authority: Dr Leung Lung Chan

Lecturer: Dr Leung Lung Chan RC-1036,
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Consultations: Please use email to arrange an appointment.

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

Lectures: Fridays 17:00-20:00 in Old Main Building G32

Moodle: Lecture notes and other material will be provided via Moodle.

Course Aims

The course provides an overview of the most important classes of financial contracts that are traded either on exchanges or over-the-counter between financial institutions and their clients. In particular, options of European and American style, futures contracts and forward contracts are discussed.

We introduce the basic ideas of arbitrage pricing within the set-up of a one-period model. In the next step, we analyse the valuation and hedging of European and American options and general contingent claims in the framework of the classic Cox-Ross-Rubinstein binomial model of the stock price.

Finally, a general theory of arbitrage free discrete time models of spot and futures markets is presented. In particular, we prove the so-called *Fundamental Theorems of Asset Pricing* (FTAP) for a finite model of security markets. The first FTAP establishes the equivalence between the no-arbitrage property of a security market model and the existence of a martingale probability measure. The second FTAP shows that the model completeness can be characterised in terms of the uniqueness of a martingale probability measure.

Relation to other mathematics courses

The course is a prerequisite for MATH5816 Continuous Time Financial Modelling.

Student Learning Outcomes

Students taking this course will develop an appreciation of the basic problems of discrete time financial modelling and be able to

- Recognise which analysis procedure is appropriate for a given research problem
- Apply probability theory and stochastic analysis to practical problems
- Understand the usefulness of probability and 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.

Relation to graduate attributes

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.

Teaching Strategies Underpinning the Course

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

Rationale for learning and teaching strategies

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 as outlined below.

We believe that effective learning is achieved when students attend all classes, have prepared effectively for classes by reading through previous lecture notes.

Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes.

Effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

The art of logically setting out mathematics is best learned by watching an expert and paying particular attention to detail. This skill is best learned by regularly attending classes.

Assessment

Assessment in this course will consist of three assignments (10% each) and a final examination (70%).

NOTE: You will need to pass the final examination to pass the course.

Knowledge and abilities assessed: All assessment tasks will assess the learning outcomes outlined above, specifically, the ability to solve mathematical problems.

Assessment criteria: The main criteria for marking all assessment tasks 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.

You should consult the School web page: http://www.maths.unsw.edu.au/currentstudents/policy-academic-misconduct

Late assignments will not be accepted (unless the delay is justified by serious reasons).

Examination

Duration: Two hours.

Rationale: The final examination will assess student mastery of the material covered in the lectures. You will need to pass the final examination to pass the course.

Weighting: 70% 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

Lecture notes for this course will be provided on Moodle.

Textbooks

Suggested textbooks:

Steven E. Shreve: *Stochastic Calculus for Finance I. The Binomial Asset Pricing Model.* Springer, 2004.

Stanley R. Pliska: *Introduction to Mathematical Finance: Discrete Time Models.* Blackwell Publishers, Oxford, 1997.

Marek Musiela and Marek Rutkowski: *Martingale Methods in Financial Modelling.* Springer-Verlag, Berlin Heidelberg New York, Second edition, 2005.

John C. Hull: *Options, Futures, and Other Derivatives.* Prentice-Hall, Englewood Cliffs, 1997.

Martin W. Baxter and Andrew Rennie: *Financial Calculus. An Introduction to Derivative Pricing.* Cambridge University Press, Cambridge, 1997.

Hans Föllmer and Alexander Schied: *Stochastic Finance. An Introduction in Discrete Time.* De Gruyter, 2000.

Moodle

All course materials will be available on Moodle. You should check regularly for new materials.

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:

http://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 http://www.maths.unsw.edu.au/currentstudents/policy-academic-misconduct

Detailed Course Schedule

1. Introduction to Financial Derivatives

1.1. A Brief review of Derivative Markets such as Forward Contracts, Call and Put Options

1.2 Introduction to Probability Theory, Conditional Expectations & Martingales

1.3. Arbitrage Pricing

1.4. Consumption and Investment

1.5. The Markov Property: Binomial Model Pricing and Hedging; and Application to Exotic Options

1.6. Stopping Times and American Options

2. The Cox-Ross-Rubinstein Model

2.1. Binomial Lattice for the Stock Price

2.2. Probabilistic Approach

2.3. American Options

2.4. Options on a Dividend-Paying Stock

3. Security Markets in Discrete Time

3.1. Finite Spot Markets

3.2. Finite Futures Markets

3.3. Futures Prices Versus Forward Prices

4. Random Walk

4.1. First Passage Times

4.2. Reflection Principle

4.3. Perpetual American Put

4.4. Applications to pricing Barrier options and Lookback options.