



COURSE OUTLINE

Never Stand Still

Science

School of Mathematics and Statistics

MATH5985

TERM STRUCTURE MODELLING

Semester 2, 2015

MATH5985 – Course Outline

Information about the Course

Course Authority: Dr DM Salopek

Lecturer: Dr Donna Mary Salopek

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

Prerequisites: The knowledge of basic results of the theory of stochastic processes, stochastic calculus and financial modelling in discrete time, as covered, for instance, by the following courses: MATH5835, MATH5975 and MATH5965.

Consultations: Fridays, 4:00-4:35 pm, RC-2054 and by appointment

Lectures: Fridays, 5.00-8.00PM, RC-1041

Course Aims

The fixed-income market is an important sector of the global financial market on which various interest rate-sensitive instruments, such as: bonds, swaps, swaptions, caps, etc. are traded. The management of interest rate risk, by which we primarily mean the pricing and hedging of interest rate products, is an important and complex issue. It creates a demand for mathematical models capable of covering all sorts of interest rate risks. Due to the somewhat peculiar way in which fixed-income securities are quoted in existing markets, theoretical term structure models are often easier to formulate and to analyse in terms of interest rates which are different from the conventional market rates.

The course will give an overview of various concepts of interest rates, and will describe the most important interest rate-sensitive contracts, such as: interest rate swaps, bond options and swaptions. The crucial part of the syllabus is the modelling of various kinds of interest rates, and the valuation of interest rate derivatives within the framework of each methodology. In particular, we deal with various classical examples of short-term rate models, the Heath-Jarrow-Morton methodology, and recently developed market models, such as, the BGM model of LIBORs and Jamshidian's model of forward swap rates. In addition, we will consider current practices in today's market and risk measures.

Relation to other mathematics courses

This course belongs to the fields of Financial Mathematics and builds on the material you have learned in Probability and Stochastic Processes. Students are expected to

have basic knowledge of discrete time financial modelling and pricing of financial derivatives.

Student Learning Outcomes

Students taking this course will develop an appreciation of the basic methods and term structure models in continuous time and pricing of financial derivatives associated with uncertainty of interest rates.

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

In particular, a student should be able

- to state definitions as specified in the syllabus
- to have working knowledge of appropriate theorems
- to apply the concepts and techniques of the syllabus to solve appropriate problems in mathematical finance
- to use specific and general results given specified assumptions
- to use terminology and reporting styles appropriately and successfully to communicate information and understanding
- understand the usefulness of these concepts in your professional area

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.

Assessment

Assessment in this course will consist of three assignments (10% each), oral presentation (10%) and a final examination (60%).

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

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.

You can work in GROUPS OF 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.

Each assignment must include a signed declaration of the plagiarism coversheet which can be found in Blackboard. Every one in the group must sign the plagiarism coversheet.

All work submitted for assessment (other than formal examination scripts) will be returned with comments on the assessment where appropriate.

Assignments must be YOUR OWN GROUP WORK, or severe penalties will be incurred.

You should consult the University web page on plagiarism

Task	Date Avail.	Date Due	Form of Submission	Weighting
Ass 1	Week 3	Fri Week 6	Written	10%
Ass 2	Week 6	Fri Week 9	Written	10%
Ass 3	Week 9	Fri Week 12	Written	10%

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

Oral Presentation

This assessment allows the student to practice their oral skills in presenting mathematical concepts related to interest rate models. Each presentation is limited to 15 minutes. You need to explain the main problem of your topic and what has been done on the problem. The aim of this exercise to introduce the class to alternative models used in term structuring which is not presented in class. This is simply a review of a model. The oral presentation will be done in Week 11 or Week 12.

Examination

Duration: Two hours.

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.

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

Additional Resources

Course Notes

Course notes from Professor Marek Rutkowski will be made available on moodle after census date.

Textbooks

Lectures will be based on

Leif B.G. Andersen and Vladimir V. Piterbarg: *Interest Rate Modeling*, Volumes 1-3. Atlantic Financial Press, London NY 2010.

Alan Brace: *Engineering BGM*, CRC Press 2007.

The following textbooks and monographs are recommended for additional reading.

Filipović, Damir: Term-structure models. A graduate course. Springer 2009

Marek Musiela and Marek Rutkowski: *Martingale Methods in Financial Modelling*. 2nd edition. Springer, 2004.

Damiano Brigo and Fabio Mercurio: *Interest Rate Models: Theory and Practice*. Springer, 2001.

Phil J. Hunt and Joanne E. Kennedy: *Financial Derivatives in Theory and Practice*. John Wiley, 2000.

Antoon Pelsser: *Efficient Methods for Valuing Interest Rate Derivatives*. Springer, 2000.

Steven E. Shreve: *Stochastic Calculus for Finance II. Continuous-Time Models*. Springer-Verlag, Berlin Heidelberg New York, 2004.

Moodle

Assessments and announcements will be available on Moodle. You should check regularly for news.

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.

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: www.maths.unsw.edu.au/students/current/policies/studentpolicy.html

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: www.lc.unsw.edu.au/plagiarism

Course Outline

- 1 Interest Rates and Related Contracts
 - 1.1 Zero-Coupon Bonds
 - 1.2 Term Structure of Interest Rates
 - 1.3 Spot and Forward Interest Rates
 - 1.4 Arbitrage-Free Family of Bond Prices
- 2 Short-Term Rate Models
 - 2.1 Merton's Model
 - 2.2 Vasicek's Model
 - 2.3 CIR Model
 - 2.4 Longstaff's Model
 - 2.5 Hull and White Model
- 3 Heath, Jarrow and Morton Methodology
 - 3.1 Absence of Arbitrage
 - 3.2 Gaussian HJM Model
- 4 Forward Measure Approach
 - 4.1 Forward Price
 - 4.2 Forward Martingale Measure
 - 4.3 Risk-neutral Valuation Formula
- 5 Options Valuation in Gaussian Models
 - 5.1 Dynamics of Forward Prices
 - 5.2 Bond and Stock Options
 - 5.3 Pricing of General Contingent Claims
- 6 Hedging of Options in Gaussian Models
 - 6.1 Put-Call Parity
 - 6.2 Hedging of Contingent Claims
 - 6.3 Futures Prices and Options
- 7 Forward and Futures LIBOR Rates
 - 7.1 Single-Period Swaps Settled in Arrears

- 7.2 Lognormal Models of Forward LIBOR Rates
- 8 Valuation of Caps and Floors
 - 8.1 Market Valuation Formula for Caps and Floors
 - 8.2 Valuation in Lognormal Model of Forward LIBOR Rates
 - 8.3 Hedging of Caps and Floors
 - 8.4 Bond Options
- 9 Interest Rate Swaps
 - 9.1 Valuation of a Forward Swap
 - 9.2 Forward Swap Rate
 - 9.3 Lognormal Model of Forward Swap Rates
- 10 Valuation of Swaptions
 - 10.1 Payer and Receiver Swaptions
 - 10.2 Market Valuation Formula for Swaptions
 - 10.3 Valuation in the Lognormal Model of Forward Swap Rates
 - 10.4 Hedging of Swaptions
- 11 Parametrisations and Affine processes
 - 11.1 Multifactor Models
 - 11.2 Consistency condition
 - 11.3 Affine Processes
 - 11.4 Affine Term Structures
- 12 Risk Measures and current issues in Interest Rate models.