Columbia University

MATH G6071 Spring 2008

Numerical Methods in Finance

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Course Overview

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OVERVIEW

This is a tentative course structure outline and is subject to change

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THE COURSE

This course introduces and applies various numerical and computational techniques useful to tackle problems in mathematical finance. Among them are different interpolation methods and their consequences during hedge, root solving techniques and their properties. The focus of this course is the pricing of derivative securities. PDE (partial differential equation) approach is discussed and their stability analyzed. Monte Carlo methods are introduced with various variance reduction techniques and their theoretical aspects are studied. We will also include applications to credit derivatives if time permits.

The course is designed to be both theoretical and practical. In the class we will deal with theoretical aspects of the numerical techniques (what works, and when it does not work, and why) using tools from pure and/or applied mathematics, with spreadsheet experimentations. Students are expected to do the same for homework assignments: some problems will be theoretical, while for the practical section spreadsheets are to be made. In this course students are challenged in both areas: Theoretical (theorems, calculations, proofs) and Practical (making spreadsheets that are working. easy to use and understand).

Our Emphasis:

- Theory
- Understanding
- Experiment
- Communications

PRE-REQUISITES

Quantitative Finance: Familiarity with the materials covered in W4071 Mathematics: Introduction to Math Finance. Roughly it means the first 15 chapters of Hull (Book 6 in the Textbooks section)

Mathematics: Strong background of linear algebra (matrices, especially eigenvalues and eigenvectors), Calculus (Taylor's expansion, integration and multivariable calculus), elementary analysis (e.g. limits), probability theory (distribution, conditional probabilities etc), stochastic calculus (e.g. ito's lemma) and statistics (mean, variance, moment generating functions) are necessary.

Computing Skills: Ability to implement algorithm involving complex calculations. Must have a good working knowledge of Microsoft Excel to complete the homework assignments, tests and exams. Students who have never done a programming project or have never created serious spreadsheets may experience extra challenges.

WHO IS IT FOR?

If you want to enhance your experience in an area that draw heavily on your mathematics, quantitative finance and implementation skills, this course may be for you.

TEXTBOOKS

	Name	Authors	Details	Comments
1	Tools for Computational Finance	Rüdiger U. Seydel	Springer; 3 edition, (May 11, 2006) ISBN: 3540279237	Required
2	Monte Carlo Methods in Financial Engineering	Paul Glasserman	Springer; 1 edition (August 7, 2003); ISBN 0387004513	Required
3	Interest Rate Models - Theory and Practice: With Smile, Inflation and Credit	Damiano Brigo (Author), Fabio Mercurio	Springer; 2nd ed. 2006. Corr. 3rd printing edition (September 26, 2007); ISBN 3540221492	Required
4	Introduction to Numerical Analysis	J. Stoer, R. Bulirsch, R. Bartels	Springer (August 21, 2002); 3 edition; ISBN 038795452X	Required
5	Excel 2007 VBA Programmer's Reference (Programmer to Programmer) (Paperback)	Paul T. Kimmel, Stephen Bullen, John Green, Rob Bovey, Robert Rosenberg, Brian Patterson	Wrox (March 26, 2007) ISBN 0470046430	Recommended / Required for Excel homework
6	Options, Futures and Other Derivatives	John Hull	Prentice Hall, 6 edition; ISBN 0131499084	Recommended reference / pre-requisite

COURSE CONTENTS

We intend to cover the following topics:

- Interpolations and root solving techniques that are used frequently in Quantitative Finance

- Pricing derivatives by the Partial Differential Equation approach (Explicit, Implicit, Crank-Nicolson Method and their stability analysis. American Option pricing as a free boundary problem)
- Pricing derivatives by the Monte Carlo Method (path generation, variance reduction techniques)

REQUIRED WORK

Students are required to complete homework assignments. They concern both theoretical and practical aspects of the topics covered in class. For the theoretical section students are required to perform mathematical calculations and proofs. For the practical section students are required to perform tasks and experiments using Microsoft Excel.

There will be interim tests and final exams. Classroom participation and other factors will also contribute to the final grade. The exact proportions will be determined later when the semester begins.

Note: In spring semester 2007 we had 6 homework assignments, 3 tests and a Final exam. Student can expect approximately an assignment due every two weeks.

GRADING

Although we want to decide the exact final grade determination schema at the beginning of the semester, it is arguably not the best practice, for it takes into no consideration of the actual characteristics of the students who are taking the class this year. As a result, below is a plan of how it might work. We will finalize the proportions in Feb or early March.

The following reflects more or less the attribution in Spring semester 2007.

	Comments	Percentage
Home works	Practice and Theory	30.00%
Short Test 1	Theory	10.00%
Mid term	Theory	15.00%
Short Test 2	Theory	10.00%
Final Exam	Theory	30.00%
Others (e.g. Class participation)		5.00%
Total		100.00%

GRADING POLICY

INTEGRITY

All solutions to the homework, test and exams (take home or otherwise) should be your work. Academic common sense should provide a good guideline and if you are in doubt please consult the instructor. A substantiated violation of the code of integrity and/or academic dishonesty (homework copying for example) may result in serious academic disciplinary action (including but not limited to a failing Grade of this course)

LATE POLICY

Homework, unless stated otherwise, are generally due one week after they are handed out.

- For written solutions, they are expected to be collected at the beginning of the class
- For spreadsheet solutions, they are expected to be emailed or given to the TA on or before the beginning of the relevant class

Late assignment receives no points. If you still want to hand it in, it should be given directly to the TA.

Late or omitted assignments due to exceptional circumstances (e.g. serious illness with doctor's note or emergency) would be handled on a case-by-case basis.

ABOUT THE INSTRUCTOR

Tat Sang Fung is an Associate Director in Misys Banking Systems, Misys. He joined Summit in 1996 and where he specializes in financial engineering and quantitative techniques. He recently coauthored the article "BGM numeraire alignment at will" published in Risk International, 2004. Tat Sang Fung holds a Ph.D. in Mathematics from Columbia University in the City of New York. In the past he has taught Differential Equations and Numerical Methods, Advanced Calculus, Basic Mathematics, College Algebra and Analytic Geometry

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