FE 621 Computational Methods in Finance - Section A

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Course objective

The main goal of a student enrolled in FE621 is to obtain essential computational tools used in the financial industry by modern financial quantitative analysts. The students are to become familiar with such methods as stochastic processes approximation, approximation for solutions to PDE's, decision methods, and simulation. The purpose is to learn to apply the results to forecasting, asset pricing, hedging, risk assessment, as well as other financial problems. Students must have a strong mathematical background (FE543/FE610), and be familiar with derivatives terminology and concepts at the level of Hull's textbook (FE620).

The course is split in modules and each module will cover theory and test the student's knowledge on developing and implementing algorithms to solve real problems.

Required material We will not have a single required textbook in this class. Such a textbook has not been written yet. However we shall be using chapters, parts, and examples from the following textbooks. The books that are most heavily used are noted below.

(a) **AB**: Aichinger, Michael and Adnreas Binder. "A Workout in Computational Finance". John Wiley & Sons, 2013. (light use - easy to read)

(b) **CS**: Clewlow, Les, and Chris Strickland. "Implementing Derivative Models (Wiley Series in Financial Engineering)." (1996). (we will use this text heavily: rank 1)

(c) **FR** Fusai, Gianluca, and Andrea Roncoroni. "Implementing Models in Quantitative Finance: Method and Cases". Springer , 2007. (moderate use: rank 2)

(d) **R** Rouah, Fabrice D. "The Heston Model and its Extensions in Matlab and C#". John Wiley & Sons, 2013. (moderate use: rank 3)

(e) Recommended reading *Options, Futures and Other Derivatives*, by John C. Hull, Prentice Hall, 2014, 9^th edition, ISBN: 0133456315 (you may get any of the older editions as the current edition is quite expensive. Use whatever edition you used in FE620).

(f) Assignments require knowledge of one of the following programming languages: C++/C#, Java. You can use Matlab or R or SAS or any computational language you wish. Please see the lab courses offerings for introduction and refresher in these programming languages.

Grades – Please submit ALL the work using pdf format

The final grade will be determined upon the student's performance in the course. We will have multiple assignments and quizzes throughout the course. Most of the grade will be coming from the in class midterm as well as from the final. The work tends to be programming intensive so an early start is necessary especially if there are gaps in your programming skills.

Only use the .pdf format for submitting assignment files. You should be able to transform any document into a pdf file. You can use Adobe acrobat - should be free to Stevens students as far as I know (please call the students help desk), or a simple alternative: use a pdf printer driver. I write all my documents in LaTeXand that typesetting program produces pdf files. A simple alternative (using any typesetting program): search on google for a driver that would print to a pdf file. Such drivers are generally free.

Late assignments will not be accepted under any circumstances without prior notice and permission of the instructor. If outside circumstances are affecting your ability to perform in the course, you must contact your instructor **before** you fall behind.

Generally the grade distribution follows the following percentages.

Table 1: Grade distribution

Assignments use latex	30%
Midterm in class	25%
Final take home	40%
~~Quizzes~~, class participation	5%

Communication and lectures

I will hold the lecture in Burchard 430.

If class lecture notes are posted on Canvas, please read them ahead of the class time. Please see the schedule posted at the end of this document.

Students are encouraged to post questions in the discussion group/forum on the web site. In general, this encourages students to exchange ideas, view points on issues related to assignments and projects. Active participation will be rewarded with bonus points. Posting solutions is not appropriate but discussing the main points of the problems is.

Schedule

Week	**Material**	**Reference Author-Chapter**
Week 1	Intro., Review Black-Scholes model	Notes, AB-1, CS-1
and	Heston and SABR models	R-1, 2
Week 2	Finding zeros of functions	F-15.1
	Greeks and Quadrature methods	CS-1, R-11, F-6
	Tree approximating methods	
Week 3	Binomial Tree Model	AB-2, 4
Week 4	Trinomial Tree Model and extensions	CS-2,3
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Week hline	Material	Reference A
	PDE approximation methods	
Week 5	Finite difference methods	AB-3, 7, CS 3, 5
to	Finite element methods	FR-4, 5.4,15,17
Week 7	Exercise frontier for American options	R-8, 10
	PDE Transformation methods	
Week 8	Laplace, Fourier methods, Heston model	AB-12, FR-7, R-4,5
Week 9	MIDTERM	
Week 10	Optimization and parameter calibration	AB-15,16 FR-24,25, R-6
	Path approximation methods	
Week 11	Random number generation	Notes, AB-9,11, CS-4
	Univariate Monte Carlo methods	FR-1,2, R-7
Week 12	Cholesky decomposition	AB-8,10 FR-13,14, R-7
	Multivariate Monte Carlo, Variance reduction	
	Markov Chain Monte Carlo (MCMC)	
	Multivariate Stochastic processes	
Week 13	PCA and Factor models	AB-17.2, CS p. 128, FR-22,23
Week 14	Copula modeling. Application to CDO	AB-14, FR-8, 22

Week 14 topic is going to be presented if time permits.

ACADEMIC INTEGRITY

Graduate Student Code of Academic Integrity *All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.*

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information includ-

ing types of violations, the process for handling perceived violations, and types of sanctions can be found at https://www.stevens.edu/directory/office-graduate-academics.

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The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the Bylaws of the Honor System document, located on the Honor Board website.