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MATH 341-01, Introduction to Financial Mathematics, Fall 2010

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Math 341 - Introduction to Financial Mathematics - Fall 2010

Course Syllabus

“In theory, theory and practice are the same.
But in practice, they are very different.”
—Casey Stengel

SUMMARY INFORMATION

Instructor: Jeff Hamrick, Ph.D., CFA, FRM

Office: Ohlendorf 318

Office Hours: 3:00-3:50 p.m. M, 10:00-10:50 a.m. W, and 3:30-4:50 p.m. Th

Office Phone: 901/843-3253

Email Address: hamrickj@rhodes.edu

Class Location: Frazier Jelke A

Class Time: 2:00-3:15 p.m. TTh

ON MATHEMATICAL FINANCE. The history of mathematical finance and quantitative models of risky asset prices can be traced to three individuals during the latter part of the 19th century: T.N. Thiele of Copenhagen, who more or less created Brownian motion while studying time series in 1880; Louis Bachelier of Paris, who created a model of Brownian motion in 1900 while trying to describe the behavior of stocks trading on the Paris *bourse*; and A. Einstein, who in 1905 used Brownian motion to describe the motion of small particles suspended in a liquid. Einstein’s work was immediately influential, but Thiele and Bachelier’s work was not recognized for decades. (Bachelier, incidentally, has become known as the father of mathematical finance, and is the namesake of one of the main professional organizations to which I belong, the Bachelier Finance Society.)

The appropriate measure-theoretic and probabilistic tools did not exist during Bachelier’s time. It took three decades of concentrated effort (interrupted by two world wars and an economic depression) by mathematicians like A.N. Kolmogorov and P. Levy to create an intellectual environment conducive to several important achievements. These achievements include, but are not limited to: the stochastic integral (by K. Ito and his students, H. Kunita and S. Watanabe, in postwar Japan), a formal proof (in a certain mathematical framework) that properly-anticipated prices fluctuate randomly (by the famous mathematical economist Paul Samuelson in 1965), a partial differential equation whose solution describes the price of a European-style call option (by F. Black and M. Scholes), and a solution to the portfolio optimization problem in continuous-time finance (by R.C. Merton in 1969).

In 1979, Coss, Ross, and Rubinstein proposed the so-called binomial method for pricing options, and they found that this method was useful for pricing American-style options (which, as we shall learn, are different from European-style options). Work by J.M. Harrison, D.M. Kreps, and S.R. Pliska further modernized the field, which was finally put on axiomatically firm and conceptually unified ground by F. Delbaen and W. Schachermayer in a series of papers in the late 1980s and early 1990s. Along the way, incredibly useful models (the Heath-Jarrow-Morton model describing the evolution of the interest rate curve, the Coss-Ingersoll-Ross model of interest rates, fractional Brownian motion as an arbitrage-free model under transaction costs, etc.) have been developed and used to create a panoply of derivative securities.

Today, the field of mathematical finance is remarkably dependent on computation and has (in some sense) broken off into a number of subfields, including financial engineering and econophysics. The field is far too important to be of interest only to academics—interacting with practitioners is a crucial aspect of being a financial mathematician. Though mathematical finance is a “hot,” intellectually challenging, and lucrative field, it has not been free of controversy (e.g., the role of financial engineers in precipitating the credit crisis of 2008-2009). Nonetheless, I hope you will enjoy learning a little bit about the field with me this semester.

ON COURSE GOALS. Any student who successfully completes this course should:

- Understand the principle of no arbitrage;
- In particular, understand the Black-Scholes arbitrage pricing of options;
- Understand and apply Ito’s formula to smooth functions of Brownian motion;
- In general, understand that the price of a security should be given by the cost of replicating its payoff;
- Understand the Capital Asset Pricing Model and Markowitz portfolio optimization;
- Understand the limits and pitfalls of Markowitz portfolio optimization;
- Be able to execute both Markowitz portfolio optimization and the binomial pricing model in a modern computer algebra system;
- Be able to hedge a position in a call option, put option, or stock using Greeks; and
- Understand a number of different stochastic models of interest rates, and use those models to price elementary interest rate derivatives.

In general, this course will prepare successful students graduate-level work in economics, finance, mathematical finance, and applied mathematics. Additionally, it is my hope that this course might help you decide if you would like to obtain a master’s degree or Ph.D. in mathematical finance (or an allied discipline) after you leave Rhodes College.

ABOUT ME. My name is Jeff Hamrick. I’m an assistant professor in the Department of Mathematics and Computer Science at Rhodes College. Please call me Jeff. My office is located in room 318 of Ohlendorf Hall. I will hold office hours from 3:00 p.m. - 3:50 p.m. noon on Mondays, 10:00 a.m. - 11:00 a.m. on Wednesdays, and 3:30 p.m. - 4:30 p.m. on Thursdays during the fall semester. My office number is 901/843-3253 and my email address is hamrickj@rhodes.edu. Please stop by my office anytime. If you’re unable to make my office hours, let me know and we may be able to schedule an appointment at an alternate time.

ABOUT YOU. You should be hard-working and enthusiastic about learning! The principal prerequisite for this course is *sufficient mathematical maturity*. I will accept as evidence of that maturity any one of the following three courses (or their equivalents from other four-year academic institutions): multivariate calculus (Math 223), linear algebra (Math 261), or probability theory (Math 311). Ideally, you will have taken all three of these courses prior to taking this course. However, I will make a considerable effort (possibly during a handful of extra evening lectures) to review the salient features of the prerequisite materials when the time is right.

ABOUT US. We will meet to talk about mathematical finance on Tuesdays and Thursdays from 2:00 p.m. - 3:15 p.m. during the fall semester. We will meet in Frazier Jelke A. We will use *Mathematics for Finance: An Introduction to Financial Engineering* by M. Capinski and T.

Zastawniak (ISBN: 978-1-85233-330-0). We will more or less cover the first through eleventh chapter in this textbook, though we will not necessarily cover every part of every chapter. Additionally, you may want to consider purchasing and using *The Mathematics of Financial Derivatives* by P. Wilmott, S. Howison, and J. Dewynne and *Options, Futures, and Other Derivatives* by J. Hull, though you should consider these two books recommended rather than required. I will place selected readings from Hull on reserve at the library.

ON ATTENDANCE. Attendance is expected in this course but is neither required nor rewarded. You may only miss a quiz or midterm examination under the most dire of circumstances, and even then only with advance consent from me.

ON HOMEWORK. Problems from the textbook will be assigned during each class period. I expect you to work on the assigned homework problems very frequently but for short periods of time. Approximately every ten calendar days, a subset of these assigned problems will be due, as noted in the course outline. In general, I encourage you to work with your colleagues, though doing so in a passive way will ultimately not serve you well. In particular, your work with your colleagues is subject to the caveat in the next paragraph.

Approximately every 10-12 calendar days (as noted on the course outline), I will ask you to write up a randomly selected handful of the previously assigned homework problems. **Once I make a formal assignment, you are no longer permitted to work with your colleagues on the assigned problems, consult with other parties, or use resources other than the course textbook.** I typically will give you very short notice (approximately 48-96 hours) to write up a formal homework assignment. It should not take long to write up your results since you should have been working on the problems anyway, right?

A special opportunity: L^AT_EX is the most prominent document preparation package used by mathematicians, economists, and other scientists. For each homework assignment for which you **nicely** type up your results in L^AT_EX (I prefer to use WinEdt with MiKTeX), I will increase your final grade in the course by two-thirds of one percent (2/3%). The web is filled with information on how to download, install, and use L^AT_EX, and I am happy to answer your questions about L^AT_EX too. (This extra credit opportunity does not apply to class projects.)

Each day, I will allot a few minutes of class time for homework-related questions. We won't have enough time to discuss many questions, so please come to my office hours, too. **I will not accept late homework assignments under any circumstances.**

ON QUIZZES. Four times during the semester we will pause and take short quizzes covering recent class material and assigned homework problems. The dates of the quizzes are noted on the course outline.

ON CLASS PROJECTS. In this course, we will complete five projects involving issues like simulation, numerical solutions to partial differential equations, and portfolio optimization. The due dates of these course projects are located on the course outline.

Because the number and sophistication of the computations in these assignments, I will ask you to use Mathematica (though, with permission, you may use MATLAB, another computer algebra system, or another programming language). **Please note: You will most likely have to take some initiative to learn a computer algebra system like Mathematica.** To help you learn Mathematica, you might consider auditing or taking Math 131, which is offered this semester on Wednesday nights from 6:00 p.m. - 8:00 p.m.

ON MIDTERM EXAMINATIONS. We will pause in the middle of the semester and take a major, in-class midterm examination during a two-hour evening meeting at a time and place that is agreeable to all of us.

ON THE FINAL EXAMINATION. A final, written, comprehensive 2.5-hour examination will be held on Monday, December 13, 2010 at 5:30 p.m. in Frazier Jelke A.

ON GRADING. I've noticed that students are too focused on grades, to the great detriment of their own learning. If students put as much effort into actually learning material as they did worrying about their grades, their performance would be much better. Nevertheless, part of my job is to assign grades fairly and in a manner that reflects the high academic standards at Rhodes College. In this class, we will use the standard ten-point scale. "Plus" or "minus" grades will be assigned to students with grades close to the extremes of each ten-point bracket (plus or minus three points from the boundary of each bracket). **In general, I do not inflate grades. Specifically, I do not curve final grades in this course. For more information about the scourge of grade inflation, see www.gradeinflation.com.**

Your grade in this course will be computed according to the following weights:

| Component | Weight |
|----------------------|---------------|
| Homework Assignments | 15% |
| Quizzes | 16% |
| Midterm Examination | 19% |
| Final Examination | 20% |
| Class Projects | 30% |

ON MISSING EXAMINATIONS. I do not, under any circumstances, offer make-up examinations due to absence or sickness. Writing a good examination (and the solutions) requires a substantial investment of my time and energy. You must plan on taking each examination.

ON CHEATING. In this class, we will adhere to the provisions of the Rhodes College Honor Code. In general, I encourage you to work on homework problems and class projects with colleagues **but you may not copy work from colleagues verbatim or merely paraphrase their work.** Obviously, you may not work with other students on examinations and you may not use crib notes or your textbook during an examination. In general, if the Rhodes College Honor Council concludes that a student in this course has violated the honor code, I will adhere to the recommendations of the Honor Council. However, I reserve the right to lower a student's grade in this course if I sincerely believe that an infraction has occurred.