M339W/M389W(unique: 52940/53285): Financial Mathematics for Actuarial Applications

Spring 2020, University of Texas at Austin

Instructor: Milica Čudina

First-Day Information Sheet

Welcome! Here is some information and some ground rules. I will stick to these rules, and I assume you will, too. Read carefully, and let me know as soon as possible – **certainly by the** 12^{th} **day of classes: February 5th, 2020** – if there is anything unclear.

Treat this document like a contract.

Technicalities

Lectures: Mon/Wed/Fri 9:00am-9:50am in PMA (RLM) 5.118.

Office Hours: Mon/Fri 11:00-11:50am and Wed 10:00am-10:50am in PMA (RLM) 13.142

My e-mail: mcudina@math.utexas.edu

Phone numbers: (512)232-6186 (the instructor's office)
(512)471-7711 (Department of Mathematics - main office)

About the Course

A few (serious) introductory remarks

- *Course URL.* `http://www.ma.utexas.edu/users/mcudina/course1.html`
- *Course description.* This course is intended to provide the **mathematical foundations** necessary to prepare for a portion of the SoA Exam IFM (thus, the CAS Exam 3F).

  Additionally, the course is aimed at building up the vocabulary and the techniques indispensable in the workplace at current financial and insurance institutions. **This is not an exam-prep seminar.**

  The material exhibited includes: review of binomial option pricing, an in- depth study of the normal and log-normal distributions, the Black-Scholes pricing formula, analysis of option Greeks, market making, Monte-Carlo simulations, mean-variance portfolio theory, asset-pricing models, market efficiency and behavioral finance, investment risk and project analysis, capital structure.

  The remainder of the Exam IFM/3F curriculum is exhibited in course M339D (also offered by the Department of Mathematics).

  A thorough understanding of probability and statistics will be needed to advance through the variated and very dense material. The students will be expected to actively participate in the class meetings and contribute to the successful conclusion of this course.

◇ *Learning objectives.*

- The student will develop understanding of the dynamics of stock prices, focusing on the renowned Black-Scholes model.
- The student will generalize the risk-neutral pricing principle established in a discrete setting to the continuous model, namely, the Black-Scholes model.
- The student will generalize the concept of sensitivity to perturbations of a single input encountered in calculus to the portfolio-price environment.
- The student will become competent in studying the relationship between exposure to risk and expected return of a financial investment.
- The student will learn to appreciate the concept of diversification - useful in real life.
- The student will link the study of financial markets to that of classical insurance.

◇ *Prerequisites.* Course M339D with a grade of at least C-.

◇ *Drop dates.* The last drop date for this class is the one announced on the academic calendar of the University of Texas at Austin (see http://registrar.utexas.edu/calendars/). This term it is **April 6th, 2020**.

A few words about the assignments and grading

Homework. **This is important information: I will not accept homework that does not conform to the guidelines that follow!**

Homework will be assigned in class and/or available on the course website. The homework will **not** be posted on *Canvas*. You will have two different ways in which to hand in your homework:

1. online submission of **typed-up** solutions through Canvas, or
2. in-person submission of handwritten solutions in the beginning of class.

You do not need to commit to a single way of submitting homework in the beginning of the course; it is acceptable to mix and match, but it is not acceptable to sumbit a single homework assignment twice. Regardless of the fashion in which your work is submitted, your solutions need to be in order and you should number the pages.

If you choose to upload your typed-up answers through Canvas, you will receive a 5% bonus on top of the score you earn in that particular assignment.

If you choose to hand in your assignment in the beginning of class when it is due, you should follow these guidelines: Homework assignments you turn in must be organized and stapled. As any business or official documents, the homework assignments must be done carefully and written legibly. Please do homework on standard-size, good-quality paper and write only on the front of each sheet. Box final answers where possible. Staple in the top left-hand corner. On the first page and the outside page write your **name, course number, assignment number, and date.** Also, put your last name on each page.

The lowest two homework scores will be dropped. The homework assignments and the due dates will be announced as the term progresses.

Having read and understood this *First-Day Handout* in its entirety will count as one homework assignment. To get the credit, read this entire document with understanding. Then complete the final page of this document and return that page to your instructor by **February 5th, 2020**. Not handing in this assignment does **not** exempt you from abiding by the First-Day Handout.

Quizzes. You should **not** expect to have quizzes and in-class assignments to be completed and handed in during our class meetings. Instead, you will have various warm-up and review worksheets to complete at home. They will all be gathered under the category of *Quizzes* when the final scores are calculated. Please, be vigilant in class to learn about how your quizzes are supposed to be sumbitted and when they are due!

The lowest two quiz scores will be dropped. The homework assignments and the due dates will be announced as the term progresses.

The In-Term Exams. The in-term exams will take place during the regular lecture time and in the same classroom. The exact dates are stated in the table at the end of this document. Especially note that the prerequisite exam is intended to cover **prerequisite material.** The coverage of the remaining two exams will be announced in class.

The Final Exam. The final exam is going to be comprehensive. That means that any material covered in class or assigned as reading can (and probably will) appear. According to the registrar's office, our final exam will take place on **Monday, May 18th (2:00-5:00pm)**. You should be rechecking this information as the term progresses.

For more information on the **uniform** UT final-examination policy, please consult

`http://catalog.utexas.edu/general-information/academic-policies-and-procedures/examinations/`

These are the things you *must* to bring to the exams:

i. a sufficient amount of paper to work on and hand-in your solutions on;
ii. calculators of any kind.

These are the things you *must not* to bring to the exams:

i. books, notes, manuals, cheat sheets, anything containing solved problems;
ii. your own standard IFM Exam or normal distribution tables (you will get a new copy to use during the exam).

Your scores are non-negotiable.

The Final Grades. Students whose total score in the assessments prior to the end of classes is above 90 will get an automatic A and will not be required to take the final exam. This total score will be calculated giving the following **weights**:

Homework average (after the two lowest scores are dropped): 12.5%

Quizzes (after the two lowest scores are dropped): 12.5%

In-term exams (each): 25%

If you miss an in-term exam for **any** reason, you are immediately out of contention for the automatic A based on the in-term average.

If you do not qualify for an automatic A, your scores will be used to calculate your final score in the course on the 100 point scale. These are the **weights** assigned to the assessment components:

Homework average (after the two lowest scores are dropped): 12.5%

Quizzes (after the two lowest scores are dropped): 12.5%

In-term exams (each): 15%

The final exam: 30%

In the end, let me caution you that there will be **no make-up in-term exams**. If you provide me with a written proof that you absence was "legitimate"(e.g., a note from your doctor or your lawyer), you can expect your mid-term score to be dropped and your final exam will then we given the extra weight of the missed in-term exam. Again, if you miss an in-term exam for whichever reason, you are immediately out of contention for the automatic A based on the in-term average.

Graduate students. Students who are taking this as a graduate course will be having extra special homework assignments. They should contact the instructor about the exact content of those assignments.

Final grades. The final letter grades will be assigned relative to your numerical score obtained from the above scheme in the following way

$$\begin{aligned} A &: 90 - 100 \\ B &: 80 - 90 \\ C &: 65 - 80 \\ D &: 55 - 65 \end{aligned}$$

The grades will not be "curved"!!!!!

- **A few bits of friendly advice**

  - ◇ *Please, come prepared to every class meeting* – review your notes, pay attention to the current material, and bring the necessary supplies (most importantly – the calculator of your choosing). **Meaningful** class participation will earn you extra credit **at the sole discretion of your instructor.**
  - ◇ *Discuss the course with your colleagues* - In order to be able to participate in class, you first need to build up a vocabulary - and there will be a lot of new vocabulary in the beginning. Who better to practice the new concepts with than your classmates who are in the same situation? I suggest that you try to work on homework assignments in pairs and small groups. Of course, you will be required to write up your own final version (and I urge you to do so - that is the only way you will be able to tell what your individual knowledge is, as opposed to the collective knowledge of your study-group).
  - ◇ *Don't try to cheat* - This is an unpleasant topic, but unfortunately a necessary one! One is often tempted to stretch the boundaries of mere discussion/collaboration with a fellow student into the territory of pure and simple cheating. In short, everything that you present as your own work (especially the work that is supposed to be graded!) should, in fact, be your own work, and not something copied from an external source. In case that a student is caught in violation of the principles of academic honesty enforced at this university, he/she is immediately reported to the higher authorities and assigned a failing grade in this course. You are expected to have read and understood the current issue of General Information Catalog, published by the Registrars Office, for information about procedures and about what constitutes scholastic dishonesty. Please visit `https://deanofstudents.utexas.edu/conduct/academicintegrity.php`.
  - ◇ *Have realistic impressions of your performance* The grading scheme for this course is described above and I do not intend to stray from it. You are solely responsible for keeping a tally of your scores throughout the semester and entering your results in the grading formula above to avoid any surprises at the end of the semester.
  - ◇ *On email and office hours* - Email should be used for brief messages about the organization of and current goings on in the course. As a rule, you should first consult the first-day handout to see if your question is answered here. If there is still any ambiguity, contact the instructor. Your instructor is handling a great number of email messages. You should not expect to have your particular email answered in less than 48 hours. You should not be asking mathematical questions via email, since they are incredibly difficult to answer through a typed message. To get an answer to this type of questions, you should come to office hours and ask in person. When coming to office hours, you should be able to present the mathematical question you have, the route(s) you took in attempting to solve the problem and the obstacles you encountered.

- *UT mandated notes*

"Counselling and Mental Health Center Student Services Bldg (SSB), 5th Floor Hours: M–F 8am–5pm

Phone: 512 471 3515

`http://www.cmhc.utexas.edu`"

"The University of Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471- 6259, 471-6441 TTY or `http://diversity.utexas.edu/disability/`"

"Religious holy days sometimes conflict with class and examination schedules. Sections 51.911 and 51.925 of the Texas Education Code relate to absences by students and instructors for observance of religious holy days.

Section 51.911 states that a student who misses an examination, work assignment, or other project due to the observance of a religious holy day must be given an opportunity to complete the work missed within a reasonable time after the absence, provided that he or she has properly notified each instructor.

It is the policy of The University of Texas at Austin that the student must notify each instructor at least fourteen days prior to the classes scheduled on dates he or she will be absent to observe a religious holy day. For religious holidays that fall within the first two weeks of the semester, the notice should be given on the first day of the semester. The student may not be penalized for these excused absences but the instructor may appropriately respond if the student fails to complete satisfactorily the missed assignment or examination within a reasonable time after the excused absence."

"This course carries the Quantitative Reasoning flag. Quantitative Reasoning courses are designed to equip you with skills that are necessary for understanding the types of quantitative arguments you will regularly encounter in your adult and professional life. You should therefore expect a substantial portion of your grade to come from your use of quantitative skills to analyze real-world problems."

This syllabus is subject to modification. Any changes will be announced in class.

A <u>VERY TENTATIVE</u> schedule

#	Wday	Date	Material to be covered
1	W	Jan 22	Orientation. Binomial asset pricing (review).
2	F	Jan 24	Binomial option pricing (review).
3	M	Jan 27	Binomial option pricing: futures options and currency options.
4	W	Jan 29	Subjective expectations and forward contracts.
5	F	Jan 31	Scaled random walk. CLT. Realized returns.
6	M	Feb 3	**Prerequisite in-term exam.**
7	W	Feb 5	The log-normal distribution. Jensen's inequality.
8	F	Feb 7	Log-normal stock prices. Parameter interpretation.
9	M	Feb 10	Measures of risk: variance, semi-variance, VaR.
10	W	Feb 12	Log-normal tail probabilities.
11	F	Feb 14	Log-normal "confidence" intervals. VaR (revisited).
12	M	Feb 17	TVaR. Coherent risk measures.
13	W	Feb 19	Log-normal partial and conditional expectations. The Black-Scholes pricing formula.
14	F	Feb 21	Black-Scholes prices [cont'd].
15	M	Feb 24	B-S pricing: Rolling insurance strategy. Gap options.
16	W	Feb 26	B-S pricing: Futures options. Currency options.
17	F	Feb 28	B-S pricing: the discrete-dividend case.
18	M	Mar 2	Greeks in the Black-Scholes pricing.
19	W	Mar 4	Focus on the Delta.
20	F	Mar 6	Option elasticity and volatility.
21	M	Mar 9	**In-term exam I.**
22	W	Mar 11	Focus on the Gamma. Other Greeks.
23	F	Mar 13	Implied volatility. $\Delta-\Gamma-\Theta$ approximation.
24	M	Mar 23	Market making and $\Delta-$hedging.
25	W	Mar 25	$\Delta-$hedger's profit.
26	F	Mar 27	$\Delta-\Gamma$-hedging.
27	M	Mar 30	Exchange options.
28	W	Apr 1	Analyzing the project. Break-even analysis.
29	F	Apr 3	Information, competition, and stock prices. Market efficiency.
30	M	Apr 6	The expected return and volatility of a portfolio. Diversification.
31	W	Apr 8	Choosing an efficient portfolio. Feasible sets. Effect of correlation.
32	F	Apr 10	Sharpe ratio.
33	M	Apr 13	Required returns. Betas of stocks. CAPM (Assumptions).
34	W	Apr 15	**In-term exam II.**
35	F	Apr 17	CAPM (Consequences).
36	M	Apr 20	Alphas of stocks.
37	W	Apr 22	Behavior of individual investors. Systematic trading biases.
38	F	Apr 24	Market efficiency (revisited). Multifactor models.
39	M	Apr 27	Capital structure.
40	W	Apr 29	Modigliani-Miller propositions.
41	F	May 1	Modigliani-Miller consequences.
42	M	May 4	Real options.
43	W	May 6	Options embedded in insurance products.
44	F	May 8	SLLN. Monte Carlo simulation.

I have read and understood
the First-Day Handout
for M339W/M389W(unique number: 52940/53285).

Signature

Legibly written: first name, last name, uteid

Date