

M339W/M389W(unique: 52940/53285): Financial Mathematics
for Actuarial Applications
Spring 2020, University of Texas at Austin
Instructor: Milica Ćudina

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 12th day of classes: February 5th, 2020** – if there is anything unclear.

Due to the COVID-19 outbreak, we have to change certain stipulations in this document. Most notably, the assessment design, the grading scheme, and the calculations for the final score have to be altered. All the changes are going to appear in blue. Please, make sure that you familiarize yourselves with them. Thank you!

Treat this document like a contract.

Technicalities

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

We will have to be meeting virtually via Zoom. You have a link to Zoom in Canvas on the left-hand side of the screen. You will be receiving an invitation from your instructor by email.

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

Office hours and individual appointments will be held using Zoom. Your dedicated times for your section are Tuesdays 10am-10:50am and Thursdays 10am-10:50am. You will receive the necessary invitation to the recurring Zoom meeting by email.

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

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

Both of the above phone numbers will not be available. Please, contact me by email if you need to.

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.

Due to reduced instruction time, some of the originally scheduled topics will be omitted. Please, consult the table on the next-to-last page of this document and the course website for the topics that will still be covered.

- ◇ *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**.
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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 submit 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.

Unfortunately, the in-person submission option is no longer available. You will have to upload your homework solutions to Canvas. The 5%-bonus will still apply to all typed-up solutions.

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 updated *First-Day Handout* in its entirety will count as another homework assignment. To get the credit, read this entire document with understanding by Tuesday, March 31st. I will be sending you a Google form through which you will be able to verify that you have read the First-Day Handout. The Google form will be due at 11:59pm on Tuesday, March 31st. Not handing in this assignment does not exempt you from abiding by this updated 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 submitted 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 quizzes and the homework will continue to be posted on the course website and your work will continue to be uploadable through Canvas.

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 in-term exams will continue to take place, but will have to be done remotely. You will receive specific instructions for each exam. I will keep a designated 50-minute time slot at our regular class time for the purpose of scheduling, but you will receive a 48-hour window during which you will be able to complete the 50-minute exam when you can and submit your solutions in Canvas. We will practice this feature through an extra-credit assignment before the actual exam(s).

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/>

Due to extenuating circumstances, there will be no comprehensive final exam.

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).

Since you will not be in our regular classroom setting, it is of utmost importance to preserve the integrity of your exam-taking. You are still not allowed to use any written notes, manuals, or any sources containing solved problems. Moreover, it is imperative that you do not communicate with anyone about the exam content prior to the due time of the exam. Finally, consulting the internet is out of bounds.

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%

Since there will be no comprehensive final exam, your final score will be calculated using the following weights:

Homework (total with three lowest scores dropped): 27.5%

Quizzes (total with three lowest scores dropped): 27.5%

In-term exams (each): 15%

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 your 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 be 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.

I trust that the way we re-organize the course will be conducive to no late assignment submissions or missed in-term exams. Having said this, if you do experience any technical difficulties in timely assignment submission, let me know and we'll work to find a solution. As always, and especially in these extreme circumstances, if there are non-academic issues you are facing, feel free to reach out to your instructor.

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

A : 90 – 100

B : 80 – 90

C : 65 – 80

D : 55 – 65

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).

Due to social distancing, it is impossible for you to have your regular study-group meetings. Please, take advantage of the "Discussions" feature in Canvas. Moreover, I have set up Piazza for this course. Let me know as soon as possible if you want to be added to it.

- ◇ *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>.

Some might find the virtual-assessment environment tempting. Remember that you are Longhorns!

- ◇ *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.

We will have office hours over Zoom at the times listed above. It would be good for you to again come prepared with questions and use our online time efficiently. If you have a math question, you can take a photo/scan of your work and email it to me as an attachment. Then, I can either respond to you directly or in office hours with your question already available for display. Unfortunately, this mode of communication will mean that I will probably have even more email to respond to. Please, be patient.

- *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 VERY TENTATIVE 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 | No class due to COVID-19. |
| 25 | W | Mar 25 | No class due to COVID-19. |
| 26 | F | Mar 27 | No class due to COVID-19. |
| 27 | M | Mar 30 | Getting used to Zoom. |
| 28 | W | Apr 1 | Market making and Δ -hedging. |
| 29 | F | Apr 3 | Δ -hedger's profit. |
| 30 | M | Apr 6 | $\Delta - \Gamma$ -hedging. |
| 31 | W | Apr 8 | Exchange options. |
| 32 | F | Apr 10 | Analyzing the project. Information, competition, and stock prices. |
| 33 | M | Apr 13 | Market efficiency. The expected return and volatility of a portfolio. |
| 34 | W | Apr 15 | In-term exam II. |
| 35 | F | Apr 17 | Diversification. Choosing an efficient portfolio. |
| 36 | M | Apr 20 | Feasible sets. Effect of correlation. |
| 37 | W | Apr 22 | Sharpe ratio. |
| 38 | F | Apr 24 | Required returns. Betas of stocks. CAPM (Assumptions). |
| 39 | M | Apr 27 | CAPM (Consequences). |
| 40 | W | Apr 29 | Alphas of stocks. |
| 41 | F | May 1 | Market efficiency (revisited). |
| 42 | M | May 4 | Multifactor models. |
| 43 | W | May 6 | Real options. |
| 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