M339W/M389W(unique: 53705/54055): Financial Mathematics for Actuarial Applications
Fall 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** 12th **day of classes: September 11th, 2020** – if there is anything unclear.

This syllabus is subject to change; students who miss class are responsible for learning about any changes to the syllabus.

Treat this document like a contract.

Technicalities

Lectures: Mon/Wed/Fri 1:00-2:00pm via **Zoom**. You will be sent further instructions and the Zoom link prior to the first class meeting. There is also a link to Zoom in Canvas on the left-hand side of the screen.

Office Hours: Tue/Thu 10:00am-10:50am via **Zoom**. You will receive the necessary invitation to the recurring Zoom meeting by email. Again, the link to Zoom in Canvas is on the left-hand side of the screen.

My e-mail: It's best to email me through Canvas. My email address is: mcudina@math.utexas.edu

Office: My usual office is PMA 13.142 (2515 Speedway, Austin, TX 78712), but I will **not** be spending any time there due to the pandemic

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About the Course

Introductory remarks

⋄ *Course URL.* https://gordanz.github.io/cudina/M339W.html

⋄ *Course description.* This course is intended to provide the **mathematical foundations** necessary to prepare for a portion of the SoA Exam IFM or the CAS Exam 3F.

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

The material exhibited includes: a 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 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 the study 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-.

⋄ *QR.* 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.

⋄ *Textbook.* There is **no required** textbook. Class notes written by the instructor will be posted on the course website. If you wish any additional resources, ask the instructor. The textbooks recommended by the SoA and CAS are:

 − *"Derivatives Markets"* by McDonald (3rd edition), and
 − *"Corporate Finance"* by Berk and DeMarzo (2nd edition).

⋄ *Class format and online attendance.* The class will be conducted completely online. Attendance for the purposes of grading will not be taken.

Online resources.

Zoom will be used for all classes and for office hours. Videos of all zoom sessions (except for private meetings) will be accessible to all students via Canvas. They will include transcripts of the lectures and chat logs (with possible delay due to processing).

Canvas will be used in this course to keep track of grades and for communication purposes. The students are responsible for the content of these announcements. The easiest way not to miss any is to turn on (i.e. not turn off) Announcements in their account's Notification menu.

Piazza will be used for informal class discussion. The system is highly catered to getting you help fast and efficiently from classmates and myself. Rather than emailing questions to the instructor, I encourage you to post your questions on Piazza. Our class signup link is `https://piazza.com/utexas/fall2020/m339w`

Sharing of Course Materials is Prohibited.

No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am well aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

Class Recordings.

Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

On assignments and grading

Homework. Homework assignments will be available on the course website. Homework assignments will **not** be posted on Canvas, however you will be uploading your solutions using Canvas. Your solutions need to be in order and you should number the pages.

> **Having read and understood this *First-Day Handout* in its entirety will count as a homework assignment. To get the credit, read this entire document with understanding by September 11th. Not handing in this assignment does not exempt you from abiding by this First-Day Handout.**

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

Quizzes. You will have various short warm-up and review worksheets to complete at home and upload to Canvas.

> The lowest two quiz scores will be dropped. The quizzes and their due dates will be announced as the term progresses.

The In-Term Exams. There will be a total of **three** in-term exams. Their dates are:

– October 5th

– November 6th

– December 11th

You will receive specific instructions for each exam. The exams themselves will be Canvas quizzes proctored by Proctorio. You will receive a 24-hour window during which you will be able to complete the 50-minute exam (at the time of your choosing) and submit your solutions in Canvas. We will practice this feature through a mock-exam homework assignment before the actual exam(s). There will be no comprehensive final exam for this course. Instead, the last in-term will be administered on the date of your university-scheduled final exam. The last in-term will have the same logistics and duration as the other in-term exams.

The Final Exam.

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

These are the things you should have available during an exam:

i. a sufficient amount of paper to work on;

ii. calculators of any kind (the *Texas Instruments TI-30XS MultiView Scientific Calculator* works well and is allowed in actuarial exams);

ii. your own IFM Exam formula sheet with the standard normal tables (available on the course website).

These are the things you *must not* have available during the exams: books, notes, manuals, cheat sheets, anything containing solved problems.

> **Since you will not be in our regular classroom setting, it is of utmost importance to preserve the integrity of your exam-taking. 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 it out of bounds.**

If you provide me with a written proof that you absence was "legitimate"(e.g., a note from your doctor), make-up arrangements will be made on a case-by-case basis.

Your scores are non-negotiable.

The Final Grades. These are the **weights** assigned to the assessment components:

Homework average (after the two lowest scores are dropped): 25%

Quizzes (after the two lowest scores are dropped): 15%

In-term exams (each): 20%

I trust that the way this course is organized will be conducive to no late assignment submissions or missed in-term exams. Having said this, if you do experience any technical or health 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

$$A \quad : 90 - 100$$
$$B \quad : 80 - 90$$
$$C \quad : 65 - 80$$
$$D \quad : 55 - 65$$

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

Some 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. You can set up your own Zoom meetings with colleagues. 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 or use Piazza.**

◇ *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, they will immediately be 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. If you have a math question, you can take a photo/scan of your work and email it to me as an attachment. To get an answer to this type of questions, you should then come to Zoom 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. Posting your question on Piazza would be the most expedient course of action.

UT mandated notes

⬦ *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 **October 29th, 2020**.

⬦ "Counselling and Mental Health Center Student Services Bldg (SSB), 5th Floor Hours: M–F 8am–5pm; phone: 512 471 3515(appointments), 512 471 CALL (crisis line); `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 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	Aug 26	Getting used to Zoom. Binomial asset pricing (review).
2	F	Aug 28	Binomial option pricing (review).
3	M	Aug 31	Binomial option pricing: futures options and currency options.
4	W	Sept 2	Real options.
5	F	Sept 4	Subjective expectations and forward contracts.
6	W	Sept 9	Scaled random walk. CLT. Realized returns.
7	F	Sept 11	The log-normal distribution. Jensen's inequality.
8	M	Sept 14	Log-normal stock prices. Parameter interpretation.
9	W	Sept 16	Measures of risk: variance, semi-variance, VaR.
10	F	Sept 18	Log-normal tail probabilities.
11	M	Sept 21	Log-normal "confidence" intervals. VaR (revisited).
12	W	Sept 23	TVaR. Coherent risk measures.
13	F	Sept 25	Log-normal partial and conditional expectations. The Black-Scholes pricing formula.
14	M	Sept 28	Black-Scholes prices [cont'd].
15	W	Sept 30	B-S pricing: Rolling insurance strategy. Gap options.
16	F	Oct 2	B-S pricing: Futures options. Currency options.
17	M	Oct 5	**In-term exam I.**
18	W	Oct 7	B-S pricing: the discrete-dividend case.
19	F	Oct 9	Greeks in the Black-Scholes pricing.
20	M	Oct 12	Focus on the Delta.
21	W	Oct 14	Option elasticity and volatility.
22	F	Oct 16	Focus on the Gamma. Other Greeks.
23	M	Oct 19	Implied volatility. $\Delta - \Gamma - \Theta$ approximation.
24	W	Oct 21	Market making and $\Delta-$hedging.
25	F	Oct 23	$\Delta-$hedger's profit.
26	M	Oct 26	$\Delta - \Gamma$-hedging.
27	W	Oct 28	Exchange options.
28	F	Oct 30	Analyzing the project. Information, competition, and stock prices.
29	M	Nov 2	Market efficiency. The expected return and volatility of a portfolio.
30	W	Nov 4	Diversification. Choosing an efficient portfolio.
31	F	Nov 6	**In-term exam II.**
32	M	Nov 9	Feasible sets.The effect of correlation.
33	W	Nov 11	Sharpe ratio.
34	F	Nov 13	Required returns. Betas of stocks. CAPM (Assumptions).
35	M	Nov 16	CAPM (Consequences).
36	W	Nov 18	Alphas of stocks.
37	F	Nov 20	Market efficiency (revisited).
38	M	Nov 23	Multifactor models.
39	M	Nov 30	Capital Structure. Modigliani-Miller.
40	W	Dec 2	Options embedded in insurance products.
41	F	Dec 4	Options embedded in insurance products [cont'd].
42	M	Dec 7	SLLN. Monte Carlo simulation.