M339D/M389D Syllabus

M339D/M389D: Introduction to Financial Mathematics for Actuaries - Fall 2023 - Syllabus

COURSE-SPECIFIC INFORMATION

Welcome to M339D/M389D! Here is some information and some ground rules. Read carefully and let me know if there is anything unclear **by the twelfth day of classes, i.e., September 6th, 2023**.

Basic info

Course number. M339D/M389D/ECO395M (unique: 55535/55860/34966)

Course meets. MWF 12noon - 12:50pm in PMA 5.120

Instructor. Milica Čudina; my office is PMA 13.142 (2515 Speedway, Austin, TX 78712).

Email. It's best to use Canvas to email the instructor. The instructor's email address is mcudina@math.utexas.edu.

Office Hours. MWF 10am-10:50am in PMA 13.142.

Course info

Course description. This course is intended to provide the **mathematical foundations** necessary to prepare for a portion of the SOA Exam FAM. Additionally, the course is aimed at building the vocabulary and the techniques indispensable in the workplace at current financial and insurance institutions. **This is not an exam-prep seminar. There is intellectual merit to the course beyond the ability to prepare for a professional exam.**

The material exhibited includes: basic risk management, forward contracts, European call/put options, the binomial asset pricing model and its application to option pricing, the Black-Scholes pricing formula, delta-hedging, and Monte-Carlo simulations.

The remainder of the Exam FAM curriculum is exhibited in courses M339J and M339U (also offered by the Department of Mathematics).

Learning outcomes.

- Familiarity with the basics of the programming language `R` and the RStudio IDE.
- Using `R` to simulate random variables.
- Getting acquainted with the basics of financial markets.
- Coding simple investment strategies in `R`.
- Using the vocabulary associated with basic options and risk management in financial markets.
- Getting introduced to the mathematical notion of arbitrage.
- Constructing a well-defined binomial asset pricing model.
- Mastering pricing by replication in the binomial asset pricing model.
- Linking the study of financial markets to that of classical insurance.
- Developing an understanding of the dynamics of stock prices, focusing on the renowned Black-Scholes model.
- Generalizing the risk-neutral pricing principle established in a discrete setting to the continuous model, namely, the Black-Scholes model.
- Generalizing the concept of sensitivity to perturbations of a single input encountered in calculus to the portfolio-price environment.

Prerequisites. The formal prerequisite is the grade C- or better in M362K and M329F. Students are assumed to be at home with the basics of probability as presented in, e.g., Ross's First Course in Probability, Pitman's Probability or Asimow and Maxwell's Probability and Statistics with Applications. Students are also assumed to be proficient in the time-value-of-money calculations both with effective and continuously compounded interest rates.

Students are **not** assumed to have any prior programming experience and the basics of `R` will be covered from scratch.

It should be stressed that this course is more sophisticated mathematically than is evident at first glance. I want you to be successful in this course, and for that to happen, a thorough understanding of probability and skillful application of notions from interest theory are necessary.

Lectures online. This class is using the *Lectures Online* recording system. This system records the audio and video material presented in class for you to review after class. Links for the recordings will appear in the *Lectures Online* tab on the Canvas page for this class. You will find this tab along the left side navigation in Canvas.

To review a recording, simply click on the Lectures Online navigation tab and follow the instructions presented to you on the page. You can learn more about how to use the Lectures Online system at http://sites.la.utexas.edu/lecturesonline/students/how-to-access-recordings/.

You can find additional information about Lectures Online at: https://sites.la.utexas.edu/lecturesonline/.

Class format and attendance. Attendance for the purposes of grading will **not** be taken. However, regular attendance is strongly recommended. In case you need to be absent, you are responsible for covering the missed material independently. Class notes will be provided on the course website. As noted above, we will be using the *Lectures Online* recording system. There will be **no** synchronous online option for this course. You are strongly encouraged to stay home if you are sick or contagious, not only to stop the spread of disease but also to promote your personal wellness. I view this class as a community of learners. We cannot learn effectively when we are ill. Please, take care of yourselves and your classmates.

Here are some university resources on COVID-19 and a link to the university's Exposure Action Chart.

If **students** are isolating, too sick to attend class, or experiencing another type of absence, they should:

- contact the Student Emergency Services immediately, and
- email the instructor as soon as they feel well enough to do so.

If the **instructor** is isolating, or too sick to attend class, she will do her best to change class modality to Zoom (with an alternative instructor if the situation calls for such drastic measures and if it's possible).

The class meetings consist of interactive lectures, coding demonstrations, and problem solving. In short, the course will incorporate a lot of active learning in class. Thus, if you miss class, you miss out on these learning opportunities. Please, come to class as much as possible.

Textbook. There is no required textbook.

Required devices. You will need access to a computer to be able to work on projects and homework. Please have your computer (or another device capable of running `R`) available in the exams as well.

Online resources.

1. **Course website**: https://mcudina.github.io/page/M339D/M339D.html. I recommend bookmarking this course site in your default browser for easy access.
2. **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.
3. **Ed Discussion** 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 Ed Discussion. It is accessible via the menu on the left-hand side in Canvas.

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. 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.

Assessment and grading

Homework assignments. Homework assignments will be available on the course website or in Canvas. You will be uploading your solutions using Canvas. Please, have your solutions in order and number the pages. Having read and understood this First-Day Handout in its entirety will count as a **part** of the zeroth homework assignment. To get the credit, read this entire document with understanding by the homework deadline. Not handing in this assignment does not exempt you from abiding by this First-Day Handout. **The lowest three homework scores will be dropped. The homework assignments and their due dates will be announced as the term progresses.**

Projects. There will be **five** in-term group projects. The nature and content of the projects will be described in more detail as new techniques are introduced. However, every group-project will be done as part of a self-assigned group of students and require critical thinking and drawing logical conclusions.

The projects are designed to include open-ended problems which do not necessarily have a unique final answer. For that reason, there is **no** checklist-type rubric for the projects. In fact, as part of your first project submission, **you** will have to contemplate and formulate what quality work means for you!

The formulations and due dates for the group projects will be available on the course website.

No late projects or homework are accepted except in dire circumstances at the sole discretion of the instructor.

In-term exams. There will be three in-term exams. All will be individual and conducted in-person in our classroom. The exam coverage will be shared on the course website ahead of the exam itself. If you miss an exam due to illness or other extenuating circumstances, the final exam will take the weight of the in-term exam you missed. If you miss more than one in-term exam, you are strongly encouraged to seek assistance from the Office of the Dean of Students to explore what your options are in such a dire situation.

Each in-term exam will consist of the following three components:

- the pre-exam quiz (20 points)
- the in-class exam (65 points)
- the post-exam reflection (15 points)

The Final Exam. This course has a **comprehensive** final exam. If higher, the final-exam score substitute the score on your lowest in-term exam. For this course and section, according to the Registrar's office, the date and time of the final exam is **Thursday, December 7, 3:30 pm-5:30 pm**.

Final grade. The final grade is composed as follows:

Assignment	Percentage of final grade
Homework	10%
Group projects	40% (8% each)
In-term exams	30% (10% each)
The final exam	20%

There is *no curve* in this class and the letter grades are assigned according to the following table:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-
94-100	90-94	86 - 90	82 - 86	78 - 82	74 - 78	70 - 74	65 - 70	60 - 65	55 - 60	50 - 55

The Final Exam Exemption. If your cumulative score in the course is above 94% ahead of the final exam, you earn an *automatic A* in the course and you do not need to take the final exam. In order to qualify for the exemption, you need to have taken all three in-term exams and submitted all the group projects.

GENERAL, UNIVERSITY- or STATE-MANDATED INFORMATION

Drop dates. The procedure/consequences are different, depending on whether you drop before or after the 4th day of classes (08/24), and then, before or after the *main drop (Q-drop) date* (10/23). (See https://ugs.utexas.edu/vick/academic/adddrop for details)

Students with Disabilities. The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. If you have a documented disability and you need specific support as a result of your disability, please let me know as soon as possible, but definitely within the first 3 weeks of class. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 (TTY), 1-866-329- 3986 (video phone) or go to http://ddce.utexas.edu/disability/

Counseling and mental health. Counseling and other mental-health services are available from **Counseling and Mental Health Center**, Student Services Bldg (SSB), 5th Floor. (hours: M–F 8am–5pm. phone: 512 471 3515, web: http://www.cmhc.utexas.edu)

Religious holy days. 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 they have 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.

Title IX Reporting/SB 212. Texas *Senate Bill 212* requires all employees of Texas universities, including faculty, report any information to the Title IX Office regarding sexual harassment, sexual assault, dating violence and stalking that is disclosed to them. Your instructor in a **mandatory reporter**. By law, your instructor must be fired if she does not report. Our Student Ombuds is confidential. Additionally, if you wish to speak with someone who can provide support **without** making an official report to the university, contact a confidential advocate at the Office of the Dean of Students by emailing advocate@austin.utexas.edu.

If you would like to speak with a case manager, who can provide support, resources, or academic accommodations, in the Title IX Office, please email supportandresources@austin.utexas.edu. Case managers can also provide support, resources, and accommodations for pregnant, nursing, and parenting students.

For more information about reporting options and resources, please visit: https://titleix.utexas.edu, contact the Title IX Office via email at titleix@austin.utexas.edu, or call 512-471-0419.

Sanger Learning Center. All students are welcome to take advantage of Sanger Center's classes and workshops, private learning specialist appointments, peer academic coaching, and tutoring for more than 70 courses in 15 different subject areas. For more information, please visit http://www.utexas.edu/ugs/slc or call 512-471-3614 (JES A332).

Important Safety Information. If you have concerns about the safety or behavior of fellow students, TAs or Professors, call BCAL (the Behavior Concerns Advice Line): 512-232-5050. Your call can be anonymous.

Further information about (campus) safety and security can be obtained from the Office of Campus Safety and Security, 512-471-5767, http://www.utexas.edu/safety/

Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.

- Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
- In the event of an evacuation, follow the instruction of faculty or class instructors. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- Link to information regarding emergency evacuation routes and emergency procedures can be found at: http://www.utexas.edu/emergency

Academic (dis)Honesty. Students who violate University rules on academic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on academic dishonesty will be strictly enforced. For further information, please visit the Student Conduct and Academic Integrity website at: http://deanofstudents.utexas.edu/conduct For a more detailed document, please consult: https://catalog.utexas.edu/general-information/appendices/appendix-c/student-conduct-and-academic-integrity/ Please, pay particular attention to the section on *plagiarism*.

This syllabus is subject to change. If you have to miss class, please make sure to check in with a classmate to learn of any updates that were made in your absence. .

The SCHEDULE of CLASSES

Date	Weekday	Topic
8/21/2023	Mon	Orientation.
8/23/2023	Wed	Setting up R and RStudio. Basics of R: Arithmetic. Vectors.
8/25/2023	Fri	R-scripts and R-notebooks. For loops.
8/28/2023	Mon	Functions in R. `If ... else` in R. Financial market models.
8/30/2023	Wed	Standing assumptions and conventions. Risky assets. Transaction costs.
9/1/2023	Fri	Outright purchase. Short sales.
9/6/2023	Wed	Historical returns of stocks. Market indices.
9/8/2023	Fri	Payoff and profit curves. Long/short positions.
9/11/2023	Mon	Basic risk management. Forward contracts.
9/13/2023	Wed	Hedging using forward contracts.
9/15/2023	Fri	European call options.
9/18/2023	Mon	European put options. Moneyness.
9/20/2023	Wed	Derivative securities. Finite probability spaces [revisited]. Arbitrage portfolios.
9/22/2023	Fri	Law of the Unique Price. Replicating portfolios. Equity-linked products.
9/25/2023	Mon	Put-call parity. Chooser options.
9/27/2023	Wed	*In-Term One*
9/29/2023	Fri	Random number generation.
10/2/2023	Mon	Inverse-Transform Method. Acceptance-Rejection Method.
10/4/2023	Wed	SLLN. Monte Carlo simulation.
10/6/2023	Fri	The binomial asset-pricing model.
10/9/2023	Mon	Forward trees.
10/11/2023	Wed	Binomial option pricing: Pricing by replication.
10/13/2023	Fri	Binomial option pricing: Risk-neutral probability.
10/16/2023	Mon	Binomial option pricing: Two periods.
10/18/2023	Wed	Multiple binomial periods.
10/20/2023	Fri	Monte Carlo for binomial option pricing.
10/23/2023	Mon	Review of the normal distribution.
10/25/2023	Wed	*In-Term Two*
10/27/2023	Fri	The normal approximation to the binomial.
10/30/2023	Mon	The limiting behavior of stock prices. More on realized returns.
11/1/2023	Wed	Moment generating functions. The log-normal distribution. Jensen's inequality.
11/3/2023	Fri	Log-normal stock prices: Parameter interpretation.
11/6/2023	Mon	Log-normal stock prices: Tail probabilities.
11/8/2023	Wed	Partial expectation.
11/10/2023	Fri	The Black-Scholes pricing formula.
11/13/2023	Mon	Forward-start options. Rolling insurance strategy.
11/15/2023	Wed	Focus on the delta.
11/17/2023	Fri	Delta-hedging.
11/27/2023	Mon	Monte Carlo with Black-Scholes pricing.
11/29/2023	Wed	*In-Term Three*
12/1/2023	Fri	Options embedded in insurance products: Part I.
12/4/2023	Mon	Options embedded in insurance products: Part II.