

MATH 5760/6890, FALL 2021
Introduction to Mathematical Finance I
Fall 2021

INSTRUCTOR INFORMATION

- Jingyi Zhu
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- Office: LCB 335
- Phone: (801) 581-3236
- Office hours in-person and on Zoom: TuTh 11:00 am - 12:30 pm, 2:00 - 3:00 pm, or by appointment.
- Accessibility and Support: the best and most efficient method to contact me is by email to the above address. For general email questions you should expect a response within a day, and I will be available 10 minutes before each class and stay after the class indefinitely.

COURSE DESCRIPTION

Prerequisites: Math 5010 (Introduction to Probability) and Math 2250 or 2270 (Linear Algebra).

Course Credit Hours: 3

COURSE DETAILS

Course Type: In Person

Location and Meeting Times: WEB L126, TuTh 9:10 - 10:30 am.

Attendance and Punctuality: All students are required to attend classes and attendance will be taken at the beginning of each class. However, each student is allowed up to **six** instances of no-attendance for the semester with no explanation required. If there is a situation involving someone being quarantined or self-isolated due to COVID-19, or ADA accommodations, or if you need to make an exception in order to attend other university activities or for medical and/or other emergency reasons, please contact me and obtain an agreement in writing. Be considerate to other students in the class by attending classes on time.

Course Materials: All materials for this course are copyrighted. Do not distribute or share course resources without instructor permission.

- Textbook: There is no formal textbook for this course, although the following books will be used in the lecture notes:

- A. Petters and X. Dong, *An Introduction to Mathematical Finance with Applications*, 1st Edition (2016), Springer Undergraduate Texts in Mathematics and Technology, ISBN-13:978-1493937813, ISBN-10: 1493937812.
 - S. E. Shreve, *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model*, (2005), Springer, ISBN-13: 978-0387249681, ISBN-10: 0387249680.
- Other References:
 - G. Campolieti and R. Makarov, *Financial Mathematics: A Comprehensive Treatment*, 1st Edition (2014), Chapman and Hall/CRC Financial Mathematics Series
 - J. Hull, *Options, Futures, and Other Derivatives*, 10th Edition (2017), Prentice Hall.
 - M. S. Joshi, *The Concepts and Practice of Mathematical Finance*, , 2nd Edition (2008), Cambridge University Press
 - Lecture notes will be posted online in the Canvas system for all registered students according to the schedule below. In addition, I will supply homework solution notes, review materials, sample exam problems and solutions following the schedule in this syllabus.

Technical Requirements:

- Canvas: Students are expected to be computer literate and Canvas skills are expected. For technical assistance, please review the Canvas Getting Started Guide for Students or contact TLT.
- Programming: Matlab and R are the preferred platforms for the course, even though other programming languages such as Python and Java are accepted.

Syllabus subject to change: This syllabus is meant to serve as an outline and guide for our course. Please note that with unforeseen development I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas.

CONTENT OVERVIEW

Mathematical finance has become a major field in applied mathematics, and also a toolkit that is believed to lead to a highly rewarded profession. Actually it is also a subject that all ordinary citizens should obtain a proper education to navigate in everyone's financial well-being. In this course, we will get a good picture of this complex financial world in mathematically solid terms, and relate the valuation and investment strategies to practical parameters that we can measure or estimate. We will also understand the principles behind the diversification advice in allocating capitals, and start to make suggestions and guidelines to investors as how to build and evaluate the portfolios for their particular objectives.

COURSE EXPECTED LEARNING OUTCOMES

- Familiarize with today's financial markets, understand what roles financial institutions and individual investors play in dealing with various securities.
- Understand the fundamental concepts of investment return and risk, and the quantifications.
- Fully understand the concept of time value of money, and be able to relate bond prices to bond yields and vice versa.
- Quantify and model the return and risk from an investment in financial assets.
- Explain the basic stock valuation and the no-arbitrage principle.
- Characterize a financial derivative according to its payoff and other parameters, and decompose into a collection of known instruments in some cases.
- Fully understand and employ the binomial tree model to price various financial derivatives.
- Demonstrate the Black-Scholes-Merton formula for an option price as a limit in the binomial model as the number of steps becomes infinitely large.
- Understand the difference between European and American style options and calculate the extra premium in an American put option, and follow an optimal exercise strategy.
- Analyze a portfolio of financial assets and use mathematical tools to optimize the portfolio performance according to a set of criteria.
- Understand the CAPM model and design optimal portfolios using market portfolios.
- Be able to extract a collection of factors from a market to explain the price movements of the securities.
- Understand the importance of fixed-income market and begin to anticipate the use of binomial tree model in pricing of fixed-income derivatives.

COURSE DESIGN

We are excited to be able to return to in-person lectures, with the advantage of giving more attentions to face-to-face interactions. Weekly lecture notes will be posted on Canvas each Monday and you are expected to come to class with some preliminary questions related to the materials in the note. If possible, we will form small groups to sketch and solve as many problems as possible, and return home to finish the details. Coursework includes weekly homework assignments (50%), two data projects (20%), and a final exam (30%).

CLASS SCHEDULE and IMPORTANT DATES

- Project due dates: October 19 and December 7.

- Final exam: Wednesday, **Dec 15**, 8:00 - 10:00 am.

Official Drop/Withdraw Dates: Last day to register without a permission code is Friday, August 27. Last day to drop class, or elect CR/NC options is Friday, September 3. Until October 22 you can withdraw from class with no approval at all. After that date you must petition to your dean's office to be allowed to withdraw. You have until Friday, December 3 to reverse CR/NC options. Please check the academic calendar for more information pertaining to dropping and withdrawing from a course. Withdrawing from a course and other matters of registration are the student's responsibility.

Holidays: There will be no class on Thursday, Nov 25 (Thanksgiving Day).

Course Schedule:

Class No	Date	Topic
1-2	Aug 24 and 26	Bank and Interest Rates, Investment Return and Risk
3-4	Aug 31 and Sept 2	Security Market and Trading
5-6	Sept 7 and 9	Net Present Values (NPV), Annuities and Bonds
7-8	Sept 14 and 16	Stock Pricing, No-Arbitrage and One-Period Binomial Model
9-10	Sept 21 and 23	Multi-Period Binomial Model
11-12	Sept 28 and 30	Martingales and Markov Processes
13-14	Oct 5 and 7	Black-Scholes-Merton Model and Formula
	Oct 12 and 14	Fall Break
15-16	Oct 19 and 21	Option Trading Strategies
17-18	Oct 26 and 28	American Derivatives
19-20	Nov 2 and 4	State Prices and CAPM
21-22	Nov 9 and 11	Markowitz Portfolio Theory
23-24	Nov 16 and 18	Efficient Frontier, Capital Market Theory
25-26	Nov 23	Passive and Active Funds
27-28	Nov 30 and Dec 2	Linear Factor Models
29-30	Dec 7 and 9	Fixed-Income Derivatives
	Dec 15	Final Exam

COMMUNICATION

- All course materials, such as lecture slides, assignments, solutions, grades, etc. will be posted on the Course Canvas site:

<https://utah.instructure.com/courses/713102>

Class announcements will be done via email through the Canvas server. You will be responsible for any information contained in them as well as the information announced in class.

- It is your responsibility to also regularly check your Umail (make sure you set up forwarding if you do not check it regularly), your Umail is the only way for me to communicate privately with you, there will be occasions during the semester that we

may need to reach out to you individually (e.g. regarding a grade or assignment) and it is in your best interest to respond promptly.

- Feel free to contact me by email for questions at zhu@math.utah.edu, I will do my best to answer emails promptly. I would like to encourage you to email me only if it is something personal that requires individual attention, if instead you have questions about logistics of the class, course material and assignments, and anything else your classmates may wonder as well, please post a question on the Canvas Discussions Board instead. This way the information is shared quickly to the entire class, and each of you can benefit from seeing other classmates questions.
- I will always do my best to ensure the communication relevant to the course is clear and transparent, it is your responsibility as well to keep yourself updated by regularly checking: the announcements on Canvas, your Umail, the posts on the Discussions Board, and pay attention to the announcements given in class and Discussion Section.
- Course Canvas Page: You are expected to log in and check Canvas **everyday** for posted announcements and assignments, and you are also strongly advised to set up notifications for Canvas so you do not miss any important notifications.

ASSIGNMENTS, ASSESSMENT AND GRADING

The course grade will be based on weekly homework (50%), two projects that will require handling of real world data (20%), and a final comprehensive exam (30%).

- Homework: Weekly assignments will be posted on Canvas each Tuesday, and submitted in the Canvas system on the following Tuesday. Late homework will be accepted only with some restrictions (see below), unless it has been requested and approved in advance for extreme circumstances.
- Projects will be posted on **Thursday, September 30**, and **Thursday, November 18**, and in each project assignment you have two weeks to work on it. Group efforts (not more than 3 students) are encouraged but each should submit your own report.
- Final Exam: **Wednesday, December 15, 2021**, 8:00 - 10:00 am. The final exam will be held in-class, with possible exceptions if there is a health condition situation. The final exam is a comprehensive exam, covering all materials discussed in the semester.
- Exam Policies: The final exam will be a closed book and closed note exam. You are allowed to bring a scientific calculator and a letter size sheet with your own handwritten notes. Under special circumstances, such as a COVID-related self-isolation, arrangements can be made to take the exam at an earlier time, or in a secured remote setting, but no makeup exam will be arranged.

Late Assignments/Missed Assignments/Regrading Policies: Assignments submitted late within one week after the due date can be accepted with a 50% reduction in credit. If you have an emergency situation that would result in late completion, you will need to email the instructor before the original due date to explain and request an extension. Proper

Table 1: Grading Scales

%-age	90-100	85-89	80-84	75-79	70-74	65-69	60-64	55-59	45-54	0-44
Grade	A	A-	B+	B	B-	C+	C	C-	D	E

adjustment can be made only after the request is granted. Regrading is only performed if the mistake is caused by the instructor or the teaching team.

Incompletes: According to university policy, to be considered for an incomplete, a student must have 20% or less of the course work remaining and be passing the course with a C or better. You must request an incomplete grade and I will consider giving that grade only under exceptional circumstances.

For Students Registered for Math 6890: If you are a PhD student, you may register at the 6000 level with a course number 6890. However, you will be required to do extra work for the course which may include: reading of some more advanced materials from the text, more theoretical exercises in homework assignments and exams, and research oriented projects that will be presented in a small discussion session. Grading curve for Math 6890 is separated from that of Math 5760.

COVID-19 CONSIDERATIONS:

University leadership has urged all faculty, students, and staff to **model the vaccination, testing, and masking behaviors** we want to see in our campus community as described in the following:

Vaccination

- **Get a COVID-19 vaccination** if you have not already done so. Vaccination is proving highly effective in preventing severe COVID-19 symptoms, hospitalization and death from coronavirus. Vaccination is the single best way to stop this COVID resurgence in its tracks.
- Many in the campus community already have gotten vaccinated:
 - More than 80% of U. employees
 - Over 70 % of U. students
- Visit <http://mychart.med.utah.edu/>, or <http://vaccines.gov/> to schedule your vaccination.

Masking

- While masks are no longer required outside of Health Sciences facilities, UTA buses and campus shuttles, CDC guidelines now call for everyone to wear face masks indoors.

- Check the CDC website periodically for masking updates - <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html>
- Treat masks like seasonal clothing (i.e. during community surges in COVID transmission, masks are strongly encouraged indoors and in close groups outside).

Testing

- **If you are not yet vaccinated, get weekly asymptomatic coronavirus tests.** This is a helpful way to protect yourself and those around you because asymptomatic individuals can unknowingly spread the coronavirus to others.
 - Asymptomatic testing centers are open and convenient:
 - * Online scheduling
 - * Saliva test (no nasal swabs)
 - * Free to all students returning to campus (required for students in University housing)
 - * Results often within 24 hours
- **Remember: Students must self-report if they test positive for COVID-19** via this website: <https://coronavirus.utah.edu/>.

ACADEMIC CODE OF CONDUCT

Students are encouraged to review the Student Code for the University of Utah:

<https://regulations.utah.edu/academics/6-400.php>

In order to ensure that the highest standards of academic conduct are promoted and supported at the University, students must adhere to generally accepted standards of academic honesty, including but not limited to refraining from cheating, plagiarizing, research misconduct, misrepresenting one's work, and/or inappropriately collaborating. A student who engages in academic misconduct as defined in Part I.B. may be subject to academic sanctions including but not limited to a grade reduction, failing grade, probation, suspension or dismissal from the program or the University, or revocation of the student's degree or certificate. Sanctions may also include community service, a written reprimand, and/or a written statement of misconduct that can be put into an appropriate record maintained for purposes of the profession or discipline for which the student is preparing.

ADDITIONAL POLICIES AND RESOURCES

Discrimination and Harassment: If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or Office of the Dean of Students, 270 Union Building, 801-581-7066. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS). Please see Student Bill of Rights, section E

<http://regulations.utah.edu/academics/6-400.php>

Undocumented Student Support: Immigration is a complex phenomenon with broad impact – those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit <https://dream.utah.edu>.

Veterans Center: If you are a student veteran, the U of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5 pm. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: <http://veteranscenter.utah.edu/>. Please also let me know if you need any additional support in this class for any reason.

Student Mental Health Resources:

- Rates of burnout, anxiety, depression, isolation, and loneliness have noticeably increased during the pandemic. If you need help, reach out for campus mental health resources, including counseling, trainings and other support.
- Consider participating in a Mental Health First Aid or other wellness-themed training provided by our Center for Student Wellness and sharing these opportunities with your peers, teaching assistants and department colleagues.

Student Success Advocates: The mission of Student Success Advocates is to support students in making the most of their University of Utah experience (<http://ssa.utah.edu>). They can assist with mentoring, resources, etc. Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact a Student Success Advocate for support.

The Americans with Disabilities Act: The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, 801-581-5020. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.

Addressing Sexual Misconduct: Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic informa-

tion. If you or someone you know has been harassed or assaulted on the basis of your sex, including sexual orientation or gender identity/expression, you are encouraged to report it to the University's Title IX Coordinator; Director, Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or to the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to police, contact the Department of Public Safety, 801-585-2677(COPS).

Campus Safety: The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit <https://safeu.utah.edu>.

University Counseling Center: The University Counseling Center (UCC) provides developmental, preventive, and therapeutic services and programs that promote the intellectual, emotional, cultural, and social development of University of Utah students. They advocate a philosophy of acceptance, compassion, and support for those they serve, as well as for each other. They aspire to respect cultural, individual and role differences as they continually work toward creating a safe and affirming climate for individuals of all ages, cultures, ethnicities, genders, gender identities, languages, mental and physical abilities, national origins, races, religions, sexual orientations, sizes and socioeconomic statuses.

Office of the Dean of Students: The Office of the Dean of Students is dedicated to being a resource to students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assists with the interpretation of University policy and regulations. Please consider reaching out to the Office of Dean of Students for any questions, issues and concerns. 200 South Central Campus Dr., Suite 270. Monday-Friday 8 am-5 pm.