

**Math 5765/6895**  
**Introduction to Mathematical Finance II**  
**Spring 2021**

**INSTRUCTOR INFORMATION**

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- Zoom Handle: <https://utah.zoom.us/j/94107072394>
- Office: LCB 335
- Phone: (801) 581-3236
- Office Hours on Zoom: MoWeFr 3:00 - 5:00 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 for another 30 minutes.

**COURSE DESCRIPTION**

**Prerequisites:** Math 5760/6890, or instructor's consent.

**Credit Hours:** 3

**COURSE DETAILS**

**Course Type:** Interactive Video Conferencing (IVC - synchronous online)

**Location and Meeting Times:** CANVAS, MoWe 1:25 - 2:45 pm

**Attendance and Punctuality:** All students are required to attend classes on Zoom, each student is allowed up to **six** instances of non-attendance for the semester. 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 by e-mail and obtain an agreement in writing. Be considerate to other students in the class by attending classes on time.

**COVID-19 Considerations:** Students must self-report if they test positive for COVID-19 via <http://coronavirus.utah.edu>.

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

- Textbook: There is no designated textbook for this course.

- Lecture notes: They will be posted online in Canvas for all registered students according to the schedule below. In addition, I will supply homework solution notes and some data sets or download links following the schedule in this syllabus.
- References:
  - *Options, Futures, and Other Derivatives*, John Hull, 10th Edition (2017), Prentice Hall. ISBN-13:978-0134472089
  - *Financial Mathematics: A Comprehensive Treatment*, G. Campolieti and R. Makarov, 1st Edition (2014), Chapman and Hall/CRC Financial Mathematics Series, ISBN-13 978-1-4398-9242-8
  - *The Concepts and Practice of Mathematical Finance*, M. S. Joshi, 2nd Edition (2008), Cambridge University Press, ISBN-13: 978-0521514088
  - *Financial Decisions and Markets: A Course in Asset Pricing*, J. Y. Campbell, (2018), Princeton University Press, ISBN 978-0691160801

### Technical Requirements:

- Zoom: Students are expected to be computer literate and Zoom navigation skills are expected. Knowledge and navigation of Canvas and Zoom are critical to access all features and resources of this course.
- Internet connection: A strong and reliable internet connection and adequate bandwidth are needed.
- Matlab: A Matlab student license is available to all students on campus, but other programming tools such as Python, R, and Java are allowed for this course. We will also be using Excel spreadsheets for class illustrations.
- Canvas: For technical assistance, please review the Canvas Getting Started Guide for Students or contact TLT.
- Loaning laptops: The Marriott Library is loaning laptops to students who need a laptop for classes. For information, please visit  
<https://lib.utah.edu/coronavirus/checkout-equipment.php>

**Syllabus subject to change:** This syllabus is meant to serve as an outline and guide for our course. Please note that with unforeseen developments 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 and posted on Canvas.

### CONTENT OVERVIEW

This is the continuation of Math 5760/6890, in which the basic ideas and practice in financial markets were introduced. In this semester we will formally use the tools of continuous-time stochastic calculus, in particular the concepts of Brownian motion and Itô calculus, to summarize the Black-Scholes pricing theory and its various extensions. The power of continuous-time models is demonstrated in their ease and transparency in dealing with

many aspects of the models to incorporate realistic factors. We will see how these tools can be used to develop models for interest rates and credit risk, and consequently for pricing of interest rate and credit derivatives. The second half of the semester will be devoted to some more recent and practical aspects of financial markets, including interest rate derivatives, credit markets, foreign exchange products, Markowitz mean variance theory and optimal portfolios, trading strategies, market liquidity, and environmental finance. We will study most applications with a data driven approach, starting with the observable market data, draw important features, and use the models to discover market inefficiency and suggest trading strategies, for either hedging purposes and speculation opportunities.

## **COURSE EXPECTED LEARNING OUTCOMES**

- Understand the fundamental concepts in using stochastic processes to model security price movements.
- Understand the general Black-Scholes-Merton model and its limitations, and the motivations behind stochastic volatility models.
- Understand various risks involved in financial markets and become familiar with various products intended to transfer those risks, which lead to trading of specific instruments.
- Be proficient in relating the prices and yields for treasury securities and corporate bonds, and can explain the concept of time value of money.
- Understand the importance and applications of interest rate models in fixed income derivative markets.
- Understand the basic framework of modern portfolio theory and construction of optimal portfolios based on investors' preferences.
- Understand the concept of value function and its connection with dynamic programming, learn about the derivation and methods to solve the Bellman equation.
- Understand the basic ideas behind statistical arbitrage strategies involved in high-frequency trading.
- Learn about efforts to use environmental investments to tackle climate change, and understand real options to impact emission dynamics.
- Understand the trading structures and the impact of asymmetric information.
- Design and perform Monte Carlo simulations to price various products with a specific model, improve the performance with variance reduction techniques.

## **COURSE DESIGN**

We will present the materials using mostly Zoom video conferencing lectures, and giving

more attention to on-the-spot student feedbacks. Diligent attendance is crucial to the success of the course as we would like to overcome the disadvantages caused by the lack of face-to-face interactions. Our attempt to achieve this is to have the lecture notes available on Canvas each Sunday ahead of the week's classes, so the main efforts during classes will be filling the details and answering questions. If possible, we will form small groups remotely to sketch and solve as many problems as possible, and each of us can try to finish the details individually. All homework and data projects assignments will be graded by the instructor on Canvas and I intend to schedule special sessions besides the regular office hours to discuss the problems and grading on Zoom.

## CLASS SCHEDULE and IMPORTANT DATES

**Official Drop/Withdraw Dates:** Last day to register without a permission code is January 22. Last day to drop class is February 12. Until March 12 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. 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. You can also elect CR/NC options and the last day to do that is April 9 and you can reverse that option before April 23.

**Holidays:** There will be no class on Monday, February 15 (President's Day) and Monday, April 5 (Non-Instructional Day).

## COURSE SCHEDULE:

Class No	Date	Topic
1	1/20	Recap of Math 5760
2-3	1/25, 27	Equity Market vs Fixed Income Market
4-5	2/1, 3	Interest Rate Models
6-7	2/8, 10	Interest Rate Derivatives
8	2/17	Credit Risk and Derivatives
9-10	2/22, 24	Stochastic Volatility
11-12	3/1, 3	Monte Carlo Methods
13-14	3/8, 10	Markowitz Efficient Frontier
15-16	3/15, 17	Modern Portfolio Theory
17-18	3/22, 24	Value Function and Bellman Equation
19-20	3/29, 31	Financial Cointegration and Statistical Arbitrage
21	4/7	High Frequency Trading Strategies
22-23	4/12, 14	Alpha Trading
24-25	4/19, 21	Asymmetric Information and Liquidity
26	4/26	Course Review

## 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/668277>

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](mailto: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.

## EXPECTATIONS FOR ONLINE LEARNING ENVIRONMENT

- Classroom equivalency: Respectful participation in all aspects of the course will make our time together productive and engaging. Zoom lectures, discussion threads, emails and canvas are all considered equivalent to classrooms and student behavior within those environments shall conform to the student code. Specifically:
  - Posting photos or comments that would be off-topic in a classroom are still off-topic in an online posting.
  - Disrespectful language and photos are never appropriate.
  - Using angry or abusive language is not acceptable, and will be dealt with according to the Student Code. The instructor may remove online postings that are inappropriate.

- Do not use ALL CAPS, except for titles, or overuse certain punctuation marks such as exclamation points and question marks.
- Course e-mails, e-journals, and other online course communications are part of the classroom and as such, are University property and subject to the Student Code. Privacy regarding these communications between correspondents must not be assumed and should be mutually agreed upon in advance, in writing.
- Other expectations for online communication:
  - Emails: When emailing your instructor keep a professional tone. Sign your message with your name and return e-mail address. Please consult this page for tips on how to write appropriate professional emails:  
<https://academicpositions.com/career-advice/how-to-email-a-professor>
  - Treat your instructor and classmates with respect in email or any other communication.
  - Remember that all college level communication should have correct spelling and grammar (this includes discussion boards).
  - Be cautious when using humor or sarcasm as tone is sometimes lost in an email or discussion post and your message might be taken seriously or be offensive to others.
  - Be careful with personal information (both yours and others).
- Electronic or equipment failure: It is your responsibility to maintain your computer and related equipment in order to participate in the online portion of the course. Equipment failures will not be an acceptable excuse for late or absent assignments.
- Online submissions: You are responsible for submitting the assignment with the required naming convention, correct file extension, and using the software type and version required for the assignment.

## ASSIGNMENTS, ASSESSMENT AND GRADING

The course grade will be based on biweekly homework assignments (50%) and five data projects (50%).

- Biweekly homework assignments: they will be posted every other week and collected in two weeks and graded accordingly.
- Five data projects: they will require handling real world data sets and programming. Group efforts are encouraged.
- There is no exam for this course.
- Homework and data project submission: all the works are submitted electronically via Canvas. We will go over the technical aspects in class to make sure that the submissions are processed smoothly.

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

**For Students Registered for Math 6895:** If you are a PhD student, you may register at the 6000 level with a course number 6895. However, you will be required to do extra work for the course which may include: reading of some more advanced materials from the references and lecture notes, and more theoretical exercises in homework assignments and data projects. Grading for Math 6895 is separated from that of Math 5765.

**Team Work:** You are encouraged to form study groups with two to three fellow students to work on the data projects. You must however submit the work by yourself and list the names of the students in your group on the work.

**Late Assignments/Missed Assignments/Regrading Policies:** Homework assignments and data projects 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 e-mail the instructor before the original due date to explain and request an extension. Proper adjustment can be made only after the request is granted.

**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.

## 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 <http://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.

**Wellness Statement:** Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at <https://wellness.utah.edu> or 801-581-7776.

**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 Universitys 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.