Department of Mathematics, University of Utah

Introduction to Mathematical Finance

Math 5760 Section 001/6890 Section 002 – Fall 2024

Course Information and Syllabus

Updated August 23, 2024

Instructor:	Akil Narayan
Email:	akil@sci.utah.edu
Phone:	801-581-8984
Office:	WEB 4666, LCB 116
Office hours:	Wednesdays 10:30-11:15 & Thursdays 10:15-11:00, WEB 4666

Class type: In Person

Class time and location: MWF, 9:40am-10:30am, WEB L126

Attendance policy: Attendance during lectures is *not* a part of your grade. However, I strongly recommend that you attend the lectures; attendance is an essential ingredient for success in this course.

Section webpage: http://www.sci.utah.edu/~akil/math5760
Note: Scores for graded assignments will be posted on Canvas.

Course Information: This is a 3-credit course.

Learning objectives: This course serves to introduce students to concepts in the field of mathematical finance. This will include general knowledge about the financial system and corresponding products, as well as rigorous and mathematically principled models for financial securities. One major goal will be the translation of valuation and investment strategies into mathematical objects and concepts that we can probe, investigate, and optimize. An introductory-level discussion of diversification, capital allocation, and financial portolio evaluation will also be provided.
Prerequisites: MATH 5010 (Introduction to probability) and MATH 2250 or 2270 (Linear algebra).

Course description: A basic introduction to the theory of financial derivative pricing. Topics include no arbitrage principle, risk-neutral measure, Black-Scholes theory, numerical model implementation and parameter calibration.

Text: Required: *An Introduction to Mathematical Finance with Applications*, 1st Edition (2016), A. Petters and X. Dong, Springer Undergraduate Texts in Mathematics and Technology, ISBN-13:978-1493937813, ISBN-10: 1493937812.

Optional supplement: *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model*, (2005), S. E. Shreve, Springer, ISBN-13: 978-0387249681, ISBN-10: 0387249680.
Class lectures will be *heavily* based on textbook material. The textbook provides additional details and alternative interpretations that cannot be covered in class due to time constraints. Homework will be assigned mostly from problems in the textbook. Access to the textbook is mandatory for success in this class.

Class meetings: This class meets in person thrice per week. Class meetings will primarily be lecture-based, which will include a discussion of theory and practice examples. I encourage you to participate in class, in particular with questions and related discussions.

Homework: Problem sets will be announced in-class and subsequently posted on the course website. Homework will be assigned approximately weekly and collected in class on the due date. Late homework assignments will be accepted, but with a 25% penalty per day late. This penalty will be enforced on Canvas, and can be waived if you provide me documentation demonstrating extenuating circumstances.

Each homework assignment is worth equal weight and your lowest homework score over the semester will be dropped. You are welcome (and encouraged) to work on the homework assignment in groups, but each student must submit individual work.

Projects: There will be two take-home projects involving programming and numerical computation. Each of the two projects will carry equal weight in determining your final grade. The due dates for these projects are October 18 and December 5.

Exams: This course will have a single in-class comprehensive final exam. The final exam will be held on Thursday, December 12 from 8am-10am in WEB L126, in accordance with university policy. The final exam will be open-book and open-notes.

Students enrolled in MATH 6890: Extra work beyond that assigned for students in 5760 will be expected. This will typically take the form of 1 or 2 extra problems in some assignments, and in some extra investigations in the projects. I also have elevated expectations for such students in terms of scientific, mathematical, and writing skills.

Grading: Your course grade will be computed as follows.

- Homework 50%
- Projects 25%
- Final exam 25%

Final letter grades will be assigned based on the following scheme:

- 92% - 100% — A
- 90% - 91% — A−
- 88% - 89% — B+
- 82% - 87% — B
- 80% - 81% — B−
- 78% - 79% — C+
- 72% - 77% — C
- 70% - 71% — C−
- 68% - 69% — D+
- 62% - 67% — D
- 60% - 61% — D−
- 0% - 59% — E

Important dates:

Aug 30		Last day to add, drop, elect CR/NC or audit classes
Oct 18		Project 1 due
Oct 18		Last day to withdraw from classes
Nov 29		Last day to reverse CR/NC option
Dec 5		Project 2 due
Dec 6		Reading Day
Dec 12	**8:00am**	Final exam

Class communication: An email list is set up with which I shall send out information not communicated during class. This email list will also be used to communicate class information in the case of unusual circumstances affecting the the logistics of the class. If you are not officially registered for the class but wish to be on the roster, please discuss it with me.

If you are registered for the course, but do not receive the course email announcements to your University of Utah email address, please notify me immediately.

The section website will be used to communicate more technical matter of the class (e.g. problem sets, lecture slides, etc.).

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to change that may be necessitated by a revised semester calendar or other circumstances. The above two methods, in addition to the coursewide website, are reliable means of getting information about changes to the course.

Communication with the instructor: The most reliable and preferred means of contacting me is via email, and I typically respond in less than 24 hours. Communication through the messaging system in Canvas will also work, but possibly with a slightly longer response time. One-on-one meetings can also be set up with me outside of office hours; please set up such meetings with me via email.

Americans With Disabilities Act (ADA) The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities.
All written information in this course can be made available in an alternative format with prior notification to the Center for Disability & Access (CDA), `https://disability.utah.edu/`. CDA will work with you and the instructor to make arrangements for accommodations. Prior notice is appreciated. To read the full accommodations policy for the University of Utah, please see Section Q of the Instruction & Evaluation regulations `http://regulations.utah.edu/academics/6-100.php`.
In compliance with ADA requirements, some students may need to record course content. Any recordings of course content are for personal use only, should not be shared, and should never be made publicly available. In addition, recordings must be destroyed at the conclusion of the course.
If you will need accommodations in this class, or for more information about what support they provide, contact:

Center for Disability & Access
801-581-5020
`disability.utah.edu` 162 Union Building 1
200 S. Central Campus Dr.
Salt Lake City, UT 84112

Academic Misconduct It is expected that students comply with University of Utah policies regarding academic honesty, including but not limited to refraining from cheating, plagiarizing, misrepresenting one's work, and/or inappropriately collaborating. This includes the use of generative artificial intelligence (AI) tools without citation, documentation, or authorization. Students are expected to adhere to the prescribed professional and ethical standards of the profession/discipline for which they are preparing. Any student who engages in academic dishonesty or who violates the professional and ethical standards for their profession/discipline may be subject to academic sanctions as per the University of Utah's Student Code: Policy 6-410: Student Academic Performance, Academic Conduct, and Professional and Ethical Conduct, `https://regulations.utah.edu/academics/6-410.php`.
Plagiarism and cheating are serious offenses and may be punished by failure on an individual assignment, and/or failure in the course. Academic misconduct, according to the University of Utah Student Code:

> *"...Includes, but is not limited to, cheating, misrepresenting one's work, inappropriately collaborating, plagiarism, and fabrication or falsification of information... It also includes facilitating academic misconduct by intentionally helping or attempting to help another to commit an act of academic misconduct."*

For details on plagiarism and other important course conduct issues, see the U's Code of Student Rights and Responsibilities, `http://regulations.utah.edu/academics/6-400.php`.

Community: It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of all backgrounds: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, culture, etc. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

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`. I will listen and believe you if someone is threatening you.

Classroom Social Interactions: Canvas allows students to change the name that is displayed AND allows them to add their pronouns to their Canvas name. Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the Center for Student Access and Resources: `https://studentresources.utah.edu`

English Language Learners: If you are an English language learner, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center (`http://writingcenter.utah.edu/`); the Writing

Program (http://writing-program.utah.edu/); the English Language Institute (http://continue.utah.edu/eli/). Please let me know if there is any additional support you would like to discuss for this class.

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 dream.utah.edu.

Veterans: If you are a student veteran, the University of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5pm.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/.

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 information.
If you or someone you know has been harassed or assaulted, you are encouraged to report it to university officials:

Title IX Coordinator & Office of Equal Opportunity and Affirmative Action
801-581-8365
oeo.utah.edu
135 Park Building
201 Presidents' Cir.
Salt Lake City, UT 84112

Office of the Dean of Students
801-581-7066
deanofstudents.utah.edu
270 Union Building
200 S. Central Campus Dr.
Salt Lake City, UT 84112

To file a police report, contact:

Campus Police & Department of Public Safety
801-585-COPS (801-585-2677)
dps.utah.edu
1735 E. S. Campus Dr.
Salt Lake City, UT 84112

If you do not feel comfortable reporting to authorities, the U's Victim-Survivor Advocates provide free, confidential, and trauma-informed support services to students, faculty, and staff who have experienced interpersonal violence.

To privately explore options and resources available to you with an advocate, contact:

Center for Student Wellness
801-581-7776
wellness.utah.edu
328 Student Services Building
201 S. 1460 E.
Salt Lake City, UT 84112

Safety at the U: The University of Utah values the safety of all campus community members. You will receive important emergency alerts and safety messages regarding campus safety via text message. For more safety information and to view available training resources, including helpful videos, visit safeu.utah.edu.
To report suspicious activity or to request a courtesy escort, contact:
Campus Polic & Department of Public Safety
801-585-COPS (801-585-2677)
dps.utah.edu
1735 E. S. Campus Dr.
Salt Lake City, UT 84112

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. To contact the Office of the Dean of Students, please email deanofstudents@utah.edu or call 801-581-7066. There is more information at https://deanofstudents.utah.edu.

Basic Needs Student Support Statement: Success at The University of Utah includes learning about and using available resources. The Basic Needs Collective (BNC) is a coordinated resource referral hub. They educate about and connect students to campus and community resources to help them meet their basic needs. As a central location for resource referrals related to food, housing, health insurance, managing finances, legal services, mental health, etc., any student experiencing difficulty with basic needs is encouraged to contact them. Drop into their office located in the Union basement or schedule with them online for an in-person or virtual visit through their webpage: https://basicneeds.utah.edu/.

Semester calendar

(Subject to change!)

Day	Date	Text Section(s)	Topic
Monday	August 19, 2024	1.1	Hello + basics
Wednesday	August 21, 2024	1.2, 1.3	Securities
Friday	August 23, 2024	1.2, 1.3	Markets
Monday	August 26, 2024	2.1-2.4	Interest
Wednesday	August 28, 2024	2.5-2.7	Net present value
Friday	August 30, 2024	2.5-2.7	Stocks and bonds
Monday	September 2, 2024	—	No class: Labor Day
Wednesday	September 4, 2024	7.5	Options basics
Friday	September 6, 2024	—	Review: Probability, linear algebra, and differential equations
Monday	September 9, 2024	—	Review: Probability, linear algebra, and differential equations
Wednesday	September 11, 2024	3.1	Markowitz portfolios
Friday	September 13, 2024	3.1	Markowitz portfolios
Monday	September 16, 2024	3.1-3.4	Markowitz portfolios
Wednesday	September 18, 2024	3.4-3.7	N-security portfolios
Friday	September 20, 2024	3.4-3.7	N-security portfolios
Monday	September 23, 2024	3.4-3.7	N-security portfolios
Wednesday	September 25, 2024	3.4-3.7	N-security portfolios
Friday	September 27, 2024	3.4-3.7	N-security portfolios
Monday	September 30, 2024	4.1	Capital market theory
Wednesday	October 2, 2024	4.2	Risk measures
Friday	October 4, 2024	4.2	Risk measures
Monday	October 7, 2024	—	No class: Fall Break
Wednesday	October 9, 2024	—	No class: Fall Break
Friday	October 11, 2024	—	No class: Fall Break
Monday	October 14, 2024	4.3	Linear factor models
Wednesday	October 16, 2024	4.3	Linear factor models
Friday	October 18, 2024	4.3	Linear factor models
Monday	October 21, 2024	5.1	Binomial tree models
Wednesday	October 23, 2024	5.1-5.2	Binomial tree models
Friday	October 25, 2024	5.1-5.2	Binomial tree models
Monday	October 28, 2024	5.2-5.3	Continuous-time models
Wednesday	October 30, 2024	5.3-5.4	Continuous-time models
Friday	November 1, 2024	5.3-5.4	Continuous-time models
Monday	November 4, 2024	5.4	Continuous-time models
Wednesday	November 6, 2024	6.7-6.8	The Itô integral
Friday	November 8, 2024	6.7-6.8	The Itô integral
Monday	November 11, 2024	6.7-6.8	Itô's formula
Wednesday	November 13, 2024	6.9	Geometric Brownian motion
Friday	November 15, 2024	6.9	Geometric Brownian motion
Monday	November 18, 2024	7.2-7.3	Forward and futures
Wednesday	November 20, 2024	7.5	Options, redux
Friday	November 22, 2024	8.1	The Black-Scholes-Merton model
Monday	November 25, 2024	8.1	The Black-Scholes-Merton model
Wednesday	November 27, 2024	—	No class: Thanksgiving break
Friday	November 29, 2024	—	No class: Thanksgiving break
Monday	December 2, 2024	8.2	Options pricing
Wednesday	December 4, 2024	8.4	Risk-neutral pricing
Thursday	December 12, 2024	8:00am-10:00am	**FINAL EXAM**