Course Syllabus

BEM 105: Options

Course Syllabus – Fall/2023
HSS, California Institute of Technology

Course Instructor: Jaksa Cvitanic, cvitanic@caltech.edu

Office Hours: tba

Teaching Assistant: TBA

Class meetings: T Th 2:30-3:55PM

Disclaimer: The syllabus is subject to change.

Course Description

An introduction to option pricing theory and risk management in the discrete-time, binomial tree model, and the continuous time Black-Scholes-Merton framework. Both the partial differential equations approach and the martingale approach (risk-neutral pricing by expected values) will be developed. The course will cover the basics of Stochastic, Ito Calculus.

Prerequisites: *A basic knowledge of calculus based probability/statistics, for example one of the following: Ec 122, Ge/ESE 118, Ma 1/103, MA 112a, MA 112b, or instructor's permission; BEM 103 strongly recommended;. Some exposure to stochastic processes and partial differential equations is helpful, but not mandatory.*

Course Welcome

FInancial derivatives are an essential tool for risk management and trading in modern financial markets, and my goal is to teach the main theoretical foundations on this topic. Since 2015, I have been using the fllipped classroom approach for this class . By moving passive learning experiences to pre-recorded media, we will be able to use live time to engage in activities such as small group problem solving and experiential learning activities. The students will have to watch the lectures and solve problems online, before we address that material in class, by participating in my MOOC "Pricing Options with Mathematical Models" available on edX. In practice sessions, we will work together on solving harder problems and discussing lectures. We will have case study presentations by student teams, andeach time another group will be invited to discuss the given presentation, and present their comments/questions on the presentation to the whole class. At the end of the term each student would be asked to do a short self-evaluation and also comment on how the team functioned. While this approach requires additional activities such as watching lectures outside of the classroom, it will

significantly reduce the amount of time needed to do the homework assignments, because we will be solving in class problems harder than the ones assigned.

Learning Outcomes

You will learn the basics of the option pricing theory. You will NOT learn much about implementation issues, such as statistical estimation of model parameters and numerical computations.

Course Website or Learning Management System

Assessment, Attendance and Participation

10% in-class case study presentation, 25% homework assignments, 30% midterm exam, 35% final exam.

Once a week, mostly on Tuesdays, we will have in-class case study presentations. The case study presentation is mandatory, that is, you fail the class if you don't do it. Moreover, attending all the case presentations is mandatory, too, unless you have a legitimate excuse. The other meeting in the week will be devoted to hands-on practice sessions, mostly on Thursdays. Students can also get up to an additional 20% of extra credit during the hands-on practice sessions, which can be used to offset loss of points in the problem sets and exams. Note that you cannot get more than 100% using extra credit. You are expected to have watched all of the lectures and completed the practice problem set for the material covered each week before the live practice session. Failure to do so will handicap your learning during these sessions. You are not required to participate in the live practice sessions. However, if you do, it will deepen your learning and will give you the chance to earn extra credit. For those taking the course on Pass/Fail: to pass the course you must pass thefi nal exam and the midterm, you must receive at least 50% of the grade for each homework, and you must participate in group case presentations and attend them. There are no extensions of the deadlines for homework problems. Penalty for late submission of the nal exam: 33% per day. Some of the problems in the homeworks and the exams will be easier to solve if you attend the practice sessions.

Academic Integrity

Caltech's Honor Code: "No member of the Caltech community shall take unfair advantage of any other member of the Caltech community."

Understanding and Avoiding Plagiarism: Plagiarism is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit, and it violates the honor code in a fundamental way. You can find more information at: http://writing.caltech.edu/resources/plagiarismLinks to an external site..

Collaboration Policy

Discussions of class material are allowed; fellow students can give hints on homework assignments; no collaboration allowed
on the exams. The homeworks and exams are open-book, open-notes. You are not allowed to consult others on the exams. You may not consult any
prepared solutions for the homework or exam problems, whether they are from this year or from previous years, from Caltech or external sources, and
you must cite any use of material from outside references. All solutions thatare handed in should be written up individually and should re ect your own
of the subject matter at the time of writing. Software produced scripts and plots are considered part of your write-up and should be done individually (you can share ideas, but not code). For group presentations, each individual should contribute approximately the same amount of effort.As a general guideline for the collaboration policy, you should be ableto reproduce any solution you hand in without help from anyone else. It is possible to achieve high scores on the homework, but still fail the exams.This likely indicates poor adherence to the collaboration policy: the object of the HW problems and the collaboration policy is to help you learn the material.

Required Text

J. Cvitanic and F. Zapatero: "Introduction to the Economics and Mathematics of Financial Markets". On reserve at the Caltech library.

There are many more advanced books on the subject, such as

S. Shreve: Stochastic Calculus for Finance II : Continuous-Time Models

T. Bjork: Arbitrage Theory in Continuous Time

K.Back: A Course in Derivative Securities: Introduction to Theory and Computation

Students with Documented Disabilities

Students who may need an academic accommodation based on the impact of a disability must initiate the request with Caltech Accessibility Services for Students (CASS). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is being made. Students should contact CASS as soon as possible, since timely notice is needed to coordinate accommodations. http://cass.caltech.edu/Links to an external site..

Undergraduate students should contact Dr. Lesley Nye, Associate Dean of Undergraduate Students (administrative contact: Beth Larranaga) and graduate students should contact Dr. Kate McAnulty, Associate Dean of Graduate Studies (administrative contact: Jacob Dalton).

Course Schedule (subject to change):
Numbers in parentheses refer to chapters/sections in the textbook. A more precise schedule is provided on the Edx MOOCwebiste of the course.

1. Main ideas: hedging and no-arbitrage; Financial Markets; options (1, 9.2)
2. Interest rates and dividend yields (2)
3. & 4. Model probabilities and state price probabilities (a.k.a. Equivalent Martingale Measure or risk-neutral probabilities): binomial model (3.1, 3.2, 3.6.1, 3.6.2, 3.6.4, 3.6.5, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.4, 7.1.1)
5. Forward and futures contracts (6.2, 6.3.9, 9.1)
6. Bounds on options prices (6.1)
7. & 8. Stochastic Calculus (3.3 except 3.3.6, 3.3.7)
9. The Black-Scholes(-Merton) model (3.3.6, 3.6.6, 7.2, 7.9)
11. More on Black-Scholes model (3.6.3, 3.6.6, 6.3.6, 6.3.7, 6.3.8, 7.1.2, 7.6.1)
12. American options; dividends; exotic options (7.3, 7.4, 7.5)
13. & 14. Stochastic volatility (7.2.4, 7.6.3, 7.6.4, 7.8)
15. Portfolio risk; Hedging (5.2, 9.3, 11.2)
16. Models with jumps/Incomplete markets (7.6.5, 7.7)
17. Interest rate models (3.4.2, 8.2.1, 8.2.2)
18. Forward rate models: Heath-Jarrow-Morton (8.2.3)

Additional Resources for Students

- **Student Wellness Center:** Wide variety of health and wellbeing services; https://wellness.caltech.edu/Links to an external site.
- **Counseling Services:** Free for all students, regardless of insurance plan; http://counseling.caltech.eduLinks to an external site.
- **Occupational Therapy:** Individual sessions and consultations on building healthy habits and routines, time management, planning and organization, and more. Free for all students; http://ot.caltech.eduLinks to an external site.
- **Center for Inclusion and Diversity**: Resources concerning navigating diversity and inclusion, including staff who can speak with students about challenges of harassment and discrimination; http://diversitycenter.caltech.eduLinks to an external site.

- **Title IX**: Caltech's Title IX Coordinator (titleix@caltech.edu) works with students on issues related to sexual harassment, sexual misconduct, and sex discrimination; http://titleix.caltech.edu/Links to an external site.
- **Caltech Accessibility Services for Students**: The Accessibility Services Specialist works with students with temporary medical conditions, or mental, physical or learning disabilities on accommodation requests and services; http://cass.caltech.eduLinks to an external site.
- **Residential Support**: Resident Associates (RAs) and Residential Life Coordinators (RLCs) are also resources for TAs and students; http://www.residentialexperience.caltech.edu/Links to an external site.
- **Career Development Center:** Provides resources to help students make career decisions and implement career plans; http://www.career.caltech.eduLinks to an external site.