BEM 105 "OPTIONS"

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Office Hours: Tuesday 2:00-2:30, and by appointment

T.A.: TBA
Disclaimer: The syllabus is subject to change.
Class meetings: T Th 2:30-3:55PM
Prerequisites: A basic knowledge of calculus based probability/statistics. Some exposure to stochastic processes and partial differential equations is helpful, but not mandatory.

Approach: I use the **flipped classroom** approach to learning. By moving passive learning experiences outside of class, we will be able to use in-class (or Zoom) time to engage in activities such as small group problem solving and case study presentations by groups of students. 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. In case study presentations each 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 group 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.

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

The case study presentations will take place once a week, mostly on Tuesdays. Every student has to be involved in one presentation, 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 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 the final 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 final 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.

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 that are handed in should be written up individually and should reflect your own understanding 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 able to 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.

Course Material:

The main textbook is:

J. Cvitanić and F. Zapatero: Introduction to the Economics and Mathematics of Financial Markets.

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

Topics (subject to change):

(Numbers in parentheses refer to chapters/sections in the textbook.)

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)