

# Economics/Mathematics C103: Introduction to Mathematical Economics

T-Th 9:30–11:00

534 Davis

Professor David Ahn

## 1 Description

C103 is an interdisciplinary topics class in mathematical economics, focusing this semester on applications of mechanism design, in particular on auctions. It is designed to introduce economics and mathematics majors to applications of mathematical reasoning in economic theory. Like any formal mathematics course, the course proceeds by presenting definitions, theorems, and proofs.

This course is *not* a review of mathematical tools for economic majors. This class will *not* provide the necessary technical skills for graduate study in economics.

As part of Berkeley's Undergraduate Student Learning Initiative (USLI), the Economics Department has developed learning goals for the Economics major. See

[http://emlab.berkeley.edu/econ/ugrad/ugrad\\_goals.shtml](http://emlab.berkeley.edu/econ/ugrad/ugrad_goals.shtml)

The specific learning goals for this course include: apply economic analysis to evaluate everyday problems; apply economic analysis to evaluate specific policy proposals; understand the role of assumptions in arguments; solve problems that have clear solutions; propose solutions for problems that do not have clear answers, and indicate under what conditions they may be viable solutions.

## 2 Prerequisites

Minimum prerequisites include multivariable calculus (Mathematics 53) and matrix algebra (Mathematics 54). These prerequisites are strictly enforced. Ideal preparation includes familiarity with the grammar of proofs (Mathematics 74) and real analysis (Mathematics 104). No prior coursework in economics is assumed, nor is necessarily helpful. The material is very abstract; this course is not for the faint of heart. Most prior students agree that C103 was the most difficult economics class they took at Berkeley. Any student with questions about her preparation should contact the instructor.

## 3 Enrollment

For the sake of fairness, enrollment issues for economics classes are *not* handled by the instructors. Any questions about enrollment should be directed to the economics department's Head GSI at [headgsi@econ.berkeley.edu](mailto:headgsi@econ.berkeley.edu), who handles enrollment for undergraduate classes. This includes questions regarding the waitlist or instructor approvals.

Please do *not* contact me with questions regarding enrollment; any questions regarding enrollment that are directed to me will be ignored. In particular, do *not* explain your reasons for needing to enroll in this course. I do *not* have any course enrollment codes.

## 4 Office hours

Tuesday and Thursday 2:00–3:00, 509 Evans Hall. Please e-mail me the day before if you plan to come to office hours. I am also happy to answer quick questions over e-mail.

E-mail: [dahn@econ.berkeley.edu](mailto:dahn@econ.berkeley.edu)

## 5 Grading

There will be two in-class midterm exams on **Tuesday October 9** and on **Thursday November 15** and a cumulative two-hour final exam on **Tuesday December 11 3:00–5:00**. All exams are closed book and closed notes. Categorically, absolutely, and without exception, exams will not be rescheduled except for official university accommodation of religious creed. Please do not enroll in the class if these dates are a problem. Any student who requires special testing accommodations should notify the instructor well before the first midterm.

Problem sets will be assigned weekly. The problem sets are coarsely graded: full credit will be given for an honest effort at all problems. Problem sets are due at the beginning of class. No late problem sets will be accepted. Honest collaboration with other students on problem sets is highly encouraged, but students are responsible for writing and understanding their own solutions. Keeping up with the problem sets is by far the best preparation for the exams.

Each Thursday class will begin with a general discussion of an open-ended question provided in a prior class. Thoughtful and regular participation in this discussion will be noted and contributed to the final grade.

Final grades will be assigned on a curve, with the median grade as the borderline between a B and a B-. The weighting is as follows:

|                                      |            |
|--------------------------------------|------------|
| Final (December 11)                  | 40 percent |
| Midterm 1 (October 9)                | 25 percent |
| Midterm 2 (November 15)              | 25 percent |
| Problem sets and class participation | 10 percent |

For each component of the grade, the z-score is computed, recalling that the z-score is

$$\frac{X_i - E[X]}{Std[X]},$$

where  $X_i$  is student  $i$ 's score,  $E[X]$  is the mean score in the class, and  $Std[X]$  is the standard deviation of scores. These z-scores are then aggregated using the mentioned weights. **There is no adjustment for improvement over the course of the semester.**

All students are accountable to the Student Code of Conduct.

## 6 Class conduct

Please come prepared to engage me and the other students. In particular, please think about the material *before* coming to lecture. Attendance and participation are a crucial part of this course, and are directly measured through class participation and attendance. Please do not enroll for this course if you will not regularly attend lectures.

**You may *not* use your laptop, phone, tablet, or any other electronic device during lectures. These distract other students. Any student found using a electronic device during lecture will have a percentage point deducted from the final grade.**

## 7 Website

The course website is hosted on the Berkeley bSpace system:

<https://bspace.berkeley.edu/portal/site/38effa5e-1d3d-4e1f-8cdd-5fe0861359db>

Notes, problem sets, solutions, and class announcements will be posted there. The website is only available to enrolled students. Until the class roster is finalized, photocopies of materials will also be distributed in class.

## 8 Course materials

The following book will be referenced regularly and is required for the course.

- Vijay Krishna, *Auction Theory, Second Edition*, Academic Press, 2009.

The first edition of the book, published in 2002, is fine as well.

## 9 Outline

Parentheses indicate readings from Krishna's book.

1. Games of complete information (Appendix F)
  - (a) Nash equilibrium
  - (b) Weak dominance
  - (c) Example: Auctions with known values
2. Overview of required probability theory
  - (a) Single dimensional random variables (Appendix A)
    - i. Distribution and density functions
    - ii. Expectation
    - iii. Hazard rate
  - (b) Multidimensional random variables (Appendix C)
    - i. Joint and marginal distributions
    - ii. Independence
    - iii. Conditional distributions
3. Games of incomplete information (Appendix F)
  - (a) Types and strategies
  - (b) Bayesian–Nash equilibrium
  - (c) Weak dominance in Bayesian games
  - (d) Second price auctions
4. Private value auctions (Chapter 2)

- (a) Order statistics (Appendix C)
  - (b) First price auctions (Chapter 2.3)
    - i. Equilibrium bidding strategies
    - ii. Welfare
    - iii. Expected revenue
5. Revenue equivalence (Chapter 3)
- (a) Revenue Equivalence Theorem
  - (b) Reserve prices
6. Mechanism design (Chapter 5)
- (a) Definition of mechanisms
  - (b) Direct mechanisms
  - (c) Revelation principle
  - (d) Envelope Theorem
  - (e) Incentive compatibility
  - (f) Individual rationality
  - (g) Myerson auction
  - (h) Vickrey–Clarke–Groves mechanism
  - (i) Arrow–D’Aspremont–Gerard-Varet mechanism