ARE201, Fall2015

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My email address is leosimon@berkeley.edu, and this is the best way to contact me. My office is 221 Giannini Hall and my cell phone number is 510 917 2916. My office hours are set tentatively to Wed, 10-11/12 am as needed; almost certainly this won't fit with your schedule; I will try to reschedule them so that they work with your schedule. I'm also available by appointment.

The class meets Tuesdays and Thursdays, from 2:00 p.m. to 3:30 p.m., in 201 Giannini. There will be a section, currently scheduled for Wed, from 9-10 a.m. in 248 Giannini. In every previous year, we have needed to change this time and place to adapt to students' schedules.

The course website is http://are.berkeley.edu/courses/ARE211/currentYear. Please bookmark the site: we will be using it constantly; all course materials will be posted on that site. I absolutely detest bcourses, and will use it as little as possible, but but grades will be posted at https://bcourses.berkeley.edu/courses/1377057. Please be sure that the email address that bcourses has for you is correct.

Course Philosophy: The primary goal of this course, and especially the lectures, is to develop a conceptual and intuitive understanding of mathematics. My teaching philosophy is that you learn how things work but seeing what breaks things: specifically, I believe the best way to learn why a theorem is true is to examine what happens when each of the theorem's underlying assumptions is violated. The course is not oriented towards computation. For example, I'll teach you what a matrix is and what it does in a way you won't have seen before. But I won't teach you about Jordan decompositions and elementary row operations on matrices. I'm assuming you've already learned how to compute things, and are here to deepen your understand of what the things you've been computing really "mean". There will be lots of pictures drawn, and a lot of emphasis on understanding what these pictures mean. (I try to make up for computation-lite lectures by getting you to compute things in the problem sets.)

Class Participation: This is a class in which people are *required* to ask a lot of questions during lecture. Many (perhaps most) of you will find the material difficult. If you are confused, chances are at least half the class is confused also. So please ask me to elaborate, clarify, give an example. Things *always* go better when somebody is willing to interrupt and ask for clarification, etc.

Lecture notes: My notes for each lecture will be available, in principle before each class, at http://are.berkeley.edu/courses/ARE211/currentYear/lecture_notes. However, there are *always* modifications to the notes that arise from the actual lecture. This is particularly true in 2015, since the course is being fundamentally reshaped. In some cases, whole sections will be added after class. For this reason, the initial posting of the notes on the web have a very ugly annoying watermark on them, to motivate me to update them.

If you download the notes prior to class, you should always try to wait till the very last possible minute to download them, and then *always* check to see if revisions have been posted. In exams, problem sets, etc., references to material in the lecture notes that has since been revised will be penalized. To ensure that you know which notes should be downloaded after class, I use a (rather imperfect) color coding system on the web which indicates whether there have been important revisions since the lecture. In the column of the lecture notes page headed Post-lecture notes, a revision with a red date has been very significantly revised since the Pre-lecture notes; one with an orange date is a significant, but not as major, revision.

The lecture notes will contain more material than we will cover in the class, but I like to leave the extra material in the notes for reference purposes. In order to be clear about which material you are responsible for, I plan to use a green font to indicate the extra, purely-for-reference material. If you print out the notes on a printer that doesn't support color, the colored text will show up in a lighter font. (I may (will surely) forget a few times to indicate all of the extra material. Please let me know by email if you think something should have been greened out but hasn't been.)

Problem sets: There will be weekly problem sets throughout the course. The are posted on `http://are.berkeley.edu/courses/ARE211/currentYear/problem_sets`. These are an *absolutely critical* component of the course. Math is learnt not from books but by doing loads of problems. I enthusiastically encourage joint work, but with a strong qualification. It's very easy to free-ride on your class-mates' work/ability/understanding. Tempting as it is to do this, the ultimate consequences are typically disastrous. So make absolutely sure you *fully understand* what it is your classmates are suggesting to you, rather than just parroting it. You may also consult with students who have taken the course in previous years. However, you may not look at either their worked problem sets or the answer keys that they have obtained. Shouldn't need to say this, but there have been incidents in past years. This year, for the first time ever, there is neither a T.A. nor a grader for this course. (Berkeley is effectively bankrupt.) I'll work out a grading system along the way but meanwhile, remember that homeworks are an essential part of the course.

Exams: There will be one exam, must likely at the end of the half-semester, but this has not yet been decided. The exam will be open-book and open-notes, *but no electronic devices permitted*. Unlike problem sets, where we encourage collaboration, all exams must be exclusively your own work.

Course Grade: Your course grade will be (more or less) a weighted average of your performance on the exam, on participation and homework, subject to instructor discretion.

Syllabus: The syllabus below is likely to be a fairly good guide to the course. However, we *never* complete everything in the syllabus, and always leave out entire subsections. So don't get worried if we seem to be running behind (we invariably do). You should expect it to be re-posted at least a couple of times.

Relationship to Econ 201: In an ideal world, you would have completed this course prior to starting Econ 201. Since the world is not ideal, you will find that you need to have learned some concepts and tools before we get to them in this class. I will attempt to do triage to deal with this problem in sections, if you notify me f triage is required.

Reference Materials: Below is a list of books for the course, *purely* for reference purposes. The lectures, which are your primary reference source, bear no particular relationship to any particular book. The first and second items in the list are all-purpose books. The others are useful for specific topics. Together with the first and second book, most people find that the lecture notes are sufficient without acquiring other books.

(1) Mathematics for Economists, by Carl Simon (no relation) and Larry Blume (SB). This is by far the most appropriate book for the course. Try to master the portions of parts I, III and IV that relate to the course. You need portions of part II, but we'll hardly do any of it in class.
(2) Mathematical Methods and Models for Economists, by Angel De La Fuente (F). Many think that this is more useful as a reference than SB.
(3) How to Read and Do Proofs, by Daniel Solow. Proofs are *always* the hardest part of this course (and others). If you haven't had much experience doing proofs, you are *guaranteed* to find it hard. This is a useful book designed for people in this position. I'm not going to assign anything from it, but many people have found it very useful. Try to work your way through it on your own, or in a group.
(4) How to Prove It: A Structured Approach, by Daniel Velleman. This is more challenging than the preceding book. Work through that one first.
(5) Mathematical Appendix to Microeconomic Theory, by Mas-Colell, Whinston and Green (MWG). Very useful extra reference book.
(6) Economists' Mathematical Manual, by Berck and Sydsaeter. (Fantastic reference book for all manner of formulae, etc., that you often need.)
(7) Elementary Classical Analysis, by J. Marsden. This is a straight math book which many, many students have found to be a very helpful adjunct to the analysis part of the course.
(8) Mathematical Economics, by Michael Carter. Many of the topics in this are too advanced for this class, but it also covers a lot of what we do. Handy as an additional reference.
(9) Mathematical Appendix to Microeconomic Analysis, by Hal Varian
(10) Mathematical Optimization and Economic Theory, by M. Intrilligator. (good for nonlinear programming section)
(11) Microeconomic Theory, by Henderson and Quandt. (Has a lot of old fashioned stuff in it that you can't find in modern textbooks but actually use a lot.)
(12) The Structure of Economics: A Mathematical Analyis, by Eugene Silberberg. (A lot of students like this: it's clear and does certain basic things in a lot of detail.)

SB refers to Mathematics for Economists, by Carl Simon and Larry Blume (SB). F refers to Mathematical Methods and Models for Economists, by Angel De La Fuente MWG refers to Mathematical Appendix to Microeconomic Theory, by Mas-Colell, Whinston and Green (MWG). The texts are only peripherally related to the course material. The chapter guides are approximate.

(1) **Linear Algebra** SB(6-11,16,23,26,27), F(3), MWG(M.D)
  (a) Linear Combinations, Linear Independence, Linear Dependence and Cones.
  (b) Vector Spaces
  (c) Spanning, Dimension, Basis
  (d) Matrices and Rank
  (e) Linear Functions
  (f) The “graph” of a linear function from $\mathbb{R}^2$ to $\mathbb{R}^2$
  (g) Determinants, Rank and volume
  (h) Solving linear equation systems and Cramer’s Rule
  (i) Eigenvalues and eigenvectors

(2) **Calculus** SB(2-4,14,30), F(4)
  (a) The fundamental notion: linear approximations to nonlinear functions.
  (b) Partial Derivative, Cross Partial and Total Derivatives
  (c) The differential in Multivariate Calculus: real-valued functions
  (d) The differential in Multivariate Calculus: vector-valued functions
  (e) Taylor’s Theorem
  (f) Application of Taylor’s theorem: 2nd order conditions for an unconstrained maximum

(3) **Constrained Optimization** SB(18,19), F(7), MWG(M.K)
  (a) Existence and Uniqueness
  (b) Necessary and sufficient conditions for a solution to an NPP
  (c) Demonstration of why the KT conditions are really necessary
  (d) Interpretation of the Lagrange Multiplier
  (e) KT conditions and the Lagrangian approach
  (f) Computing a solution to a NPP: a worked example
  (g) Second Order conditions for a Constrained Maximum

(4) **Comparative Statics** SB(15,19.2), F(5.2), MWG(M.E, M.L)
  (a) The envelope theorem (unconstrained version).
  (b) The envelope theorem (constrained version).
  (c) Implicit function theorem
  (d) The implicit function theorem and comparative statics.