ECON-4120 Quantitative Analysis
ECON-6920 Advanced Quantitative Analysis

Syllabus

Fall 2009
Ken Simons

Mathematics is essential for economics, and this course ensures you are familiar with key mathematical tools and with the application of these mathematical tools to economic problems. The language of economics and the methods of economic analysis are, in large part, mathematics. Hence the course is valuable for anyone considering graduate work in economics, applying economic methods in business, engineering, or finance, or applying quantitative techniques to social science disciplines. Mathematical topics are expected to include: basic derivatives and optimization, matrix algebra solution methods, multivariate derivatives, multivariate optimization with and without constraints, basic difference and differential equations and simulation, and basic probability. Economic applications will be considered throughout the course; for example, firms' R&D decisions, economic production and consumption, macroeconomic cycles, investment portfolios, and bargaining.

Course Goals

Your goals in this course are:

- Ensure you have mastered mathematical skills commonly used in economics.
- Gain experience applying these methods to economics-related issues.

Grades

Grades will be determined by weekly assignments (10%), six short quizzes (50%), and a group project (40%). The first five quizzes are required for undergraduate credit and the sixth is required for graduate credit and optional for undergraduates. I will average your best 4 (for undergraduate credit) or 5 (for graduate credit) quiz scores to determine your quiz grade average. I will drop your lowest assignment grade when computing an assignment grade average, and for undergraduates the last two assignments are optional and can replace lower assignment grades. Project grades will be determined half by a written document, and half by an oral presentation anonymously assessed (largely) by other students. Attendance is required and sometimes affects grades (attendance of others' project presentations counts toward your project grade).

Late assignments receive 80% credit if up to one class session late and 50% credit up to two weeks late but by the last day of classes (after the last day of classes, no assignments can be accepted). Assignments can be done with other people – this is a good way to learn – but *you must write up your own assignment* (using your own words and expressions). Quizzes must be done on your own. Projects may be done in small groups, as we will discuss. Intellectual dishonesty, specifically cheating on quizzes and plagiarism, will generally result in a Fail grade and referral to the Dean of Students' office for possible further action (I am required to state this policy). Grade feedback will be given circa the middle of term. Grade appeals are only granted in cases of administrative error, but if you think there has been an error submit your appeal to

Prof. Simons (if rejected students are allowed to appeal in writing to the Economics Department Chair within five Institute business days).

Required Text

Jeffrey Baldani, James Bradfield, and Robert W. Turner, *Mathematical Economics*, 2nd ed., Thomson South-Western, 2005.

Prerequisites and Supplementary Texts

Prerequisites are a working knowledge of calculus, some experience using matrices, and at least a couple courses in economics including some micro- (managerial) or macroeconomics. Students whose calculus skills are weak or have never done matrix algebra can take the course on request, but should be prepared for extra work equivalent to a tough extra course.

The following supplementary books may help you learn and practice:

Alpha C. Chiang and Kevin Wainwright, *Fundamental Methods of Mathematical Economics*, 4th ed., New York: McGraw-Hill, 2005. This classic and widely-used text provides good hands-on practice and leads you steadily through the stages of mathematical skills used in economics. It is a bit "cookbook" in its lack of proofs. An older edition is fine.

Carl P. Simon and Lawrence Blume, *Mathematics for Economists*, New York: Norton, 1994. Excellent overview of key mathematical skills at the graduate level. Goes slightly beyond Chiang's text, and does not leave readers afraid of proofs.

Our text and these books introduce mathematical tools for economics, using standardized cookbook methods that work again and again. Cookbook methods are great for basic jobs of economics, but in practice you often need to be creative and to get beyond fear of proofs. Try:

Paul Zeitz, *The Art and Craft of Problem Solving*, 2nd ed., Wiley, 2006. Helps you creatively solve mathematical problems and enjoy proofs.

If you are serious about being able to develop economic theory as part of your work, you should also read the theoretical literature in your area(s) of economics and practice proving results in published papers in leading journals.

Tentative Schedule of Class Sessions

Monday (M), Thursday (R) 10:00-11:50. "[A…]" means assignment due on chapters or topics specified. "[Q…]" means quiz on chapters or topics specified. Readings, assignments, and quiz for 13-14 and probability are required for graduate students and optional for undergraduates.

M Aug 31	Introduction to the course
R Sep 3	Ch. 1: Derivatives, optimization, and the envelope theorem
R Sep 10	Ch. 2: Applications of derivatives, optimization, and the envelope theorem *and sign up for projects*
M Sep 14	Ch. 3: Matrix methods [A 1-2]
R Sep 17	Ch. 4: Applications of matrix methods
M Sep 21	Ch. 5: Multivariate calculus (w/ differentials, implicit function theorem, level curves, homogeneity) [A 3-4]
R Sep 24	Ch. 6: Applications of multivariate calculus [Q 1-4]
M Sep 28	Dynamics 1A: Feedback processes [A 5-6]
R Oct 1	Dynamics 1B: Model conceptualization
M Oct 5	Dynamics 2A: Stocks and flows, graphical integration [A Dynamics 1]
R Oct 8	Dynamics 2B: Model formulation and analysis [Q 5-6 & Dynamics 1]
T Oct 13	Dynamics 3A: Simulation methods [A Dynamics 2] *Mon. class schedule on Tue.*

R Oct 15	Dynamics 3B: Simulation methods continued
M Oct 19	Ch. 15: Difference and differential equations [A Dynamics 3]
R Oct 22	Practice with Difference and differential equations [Q Dynamics 2-3]
M Oct 26	Ch. 16: Applications of difference and differential equations
R Oct 29	Ch. 7: Multivariable optimization without constraints [A 15-16]
M Nov 2	Ch. 8: Applications of multivariable optimization without constraints
R Nov 5	Ch. 9: Equality-constrained optimization [A 7-8]
M Nov 9	Ch. 10: Applications of equality-constrained optimization [Q 15-16 & 7-8]
R Nov 12	Ch. 11: Inequality-constrained optimization [A 9-10]
M Nov 16	Ch. 12: Applications of inequality-constrained optimization
R Nov 19	Ch. 13-14: Value functions and the envelope theorem & apps. [A 11-12]
M Nov 23	Probability (mass and density functions, cumulative density functions, moments) [Q 9-12]
M Nov 30	Applications of probability [A 13-14]
R Dec 3	Project presentations [A probability]
M Dec 7	Project presentations [Q 13-14 & probability]
R Dec 10	Project presentations
F Dec 11	[Written project reports, and any last assignments, due (on paper) by 4:00 p.m.]

Software

We will use the program Vensim for simulation. Please download a free copy from http://www.vensim.com/freedownload.html. The program is free for educational use.

Teaching Team, Office Hours and Contact Details

Prof. Kenneth L. Simons: email simonk@rpi.edu, 276-3296, room Sage 3407. Office hours: anytime, just stop by, or sign up for a slot Mondays 12:30-1:30 or 4:15-5:15. You sign up outside my office to guarantee a slot in the Monday times (if you do not sign up by 11:50 or 3:50 for the forthcoming office hours block then occasionally I might make other arrangements so occasionally will not be in). TA Veronica Wang: email wangc8@rpi.edu, room Sage 3703, office hours Tuesday and Friday, 11:30-12:30.

Prof. Kenneth L. Simons is a leading industrial economist with considerable research and applied experience using quantitative techniques. He has taught economics for over a decade at the University of London (1995-2003) and RPI (2003 to date). He has designed new courses in Industrial Growth and Competition and quantitative techniques for economics. As an undergraduate at MIT he was a teaching assistant for MBA, PhD, and executive courses in system dynamics. He also developed and formally taught small-group courses in chemistry and differential equations to MIT undergraduates (for formal course credit as approved alternatives to the standard curriculum). He received MIT's most prestigious award to undergraduates, the Karl Taylor Compton Prize, for his contribution to education at MIT (the award is given for service and contributions to the university; another recipient is RPI's President Shirley Jackson). He has developed computer-based and tabletop simulations for teaching purposes; these are used in his own courses and at other universities. His research is primarily in industrial organization and technological change, areas in which he has numerous publications and papers. He has been Chairman of the Network of Industrial Economists and his research on industry and technology dynamics is funded by the Kauffman Foundation and the National Science Foundation.

Veronica Wang is a PhD student in Economics at RPI, with experience in quantitative methods and econometrics. She researches rural development in China, especially imbalanced development between rural areas and cities.