UNIVERSITY OF COLORADO
BOULDER, COLORADO

Economics 4868:
Optimization and Simulation Modeling in Microeconomics

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Office: Economics Building 216,
Office Hours: MFW 09:00 - 10:30 or immediately after class

Course Outline and Reading List

This is a new course not only to CU Economics, and it is something I am crafting from scratch. There is no textbook or other off-the-shelf materials for it (I have taught it once). It should be of interest to students in applied math, computer science and engineering as well as to economics majors. Section size is capped at 30. We take problems from microeconomic theory, public economics, labor, trade, and environmental economics and translate them into numerical, computable models. I am also adding a new part of the that treat some classic problems in "operations research" (such as a network pricing and supply problem) that is very useful when you come to look for jobs.

The good news: there are no exams. Assessment is by problem sets and each student will be in a group project, described below. Last year's course rating was 4.9 and instructor 5.3 (out of 6). Work level was 3.7 out of 5.0. There were no complaints that the course was too difficult or demanding, though there were three who dropped rather late.

The bad news: because there is no textbook and we work through all material in class, attendance at all classes mandatory. Three missed classes results in a full grade point deduction. No kidding. There will be exercises due every second week, and it is mandatory that these all be done and done on time. There will be an exercise due the second week of class, and failing to turn any exercise in on time results in the lost of a quarter grade point.

Intermediate microeconomics, Econ 3070 is necessary (as well as formally required) for the course. The level of math required will NOT be higher than any other 4000 level economics course, nor will the work load. But the nature, requirements, and pacing of the course will be somewhat different. Indeed, there is going to be a lot of "play it by ear" and I am prepared to adapt and improvise when a need or problem becomes clear.

Some of the course is related to what is commonly called "operations research", which is an amalgamation of economics, engineering and applied math. We will of course focus a lot more on the economics parts of operations research, but I'm adding to the latter as just noted.

The idea behind the course is to translate economic ideas and models that are dealt with graphically and algebraically into computable, solvable simulation models. I am hoping that this will prove to be fun as well as really solidifying people's understanding of economics. We will be able to try out ideas and scenarios in order to see the quantitative effects of changes to the economy. These could include taxes and subsidies, environmental externalities, income redistribution policies, international trade restrictions and liberalizations, public goods and so forth. We will learn how to dump simulation output to excel and create graphics.

The course will use a software package called GAMS (general algebraic modeling system), a demo version which is downloadable for free - and large enough for anything we will be doing. It is already installed on all the machines in the Econ building undergraduate computer lab. GAMS is widely used by economists and engineers for optimization problems and for solving systems of equations and inequalities (e.g., GAMS is used by engineers for refinery scheduling programs, by logistics managers for airlines and shipping companies).

Look for the file "Welcome to GAMS" on my personal website for downloading and installing the software. I hope you will find it fairly easily. You can find this at:

http://spot.colorado.edu/~markusen
Then click on "Teaching" on the left menu
Then under "Simulation Modeling in Microeconomics", click on "GAMS Chapter 1 2012 (Jensen)"

Or you can go there directly at:
http://spot.colorado.edu/~markusen/teaching_files/applied_general_equilibrium/GAMS/intro1.pdf

I very much hope that you will do this before the first class.

By the end of the first week, you will also need to start reading
http://spot.colorado.edu/~markusen/teaching_files/applied_general_equilibrium/GAMS/intro2.pdf

I am sorry to say that GAMS doesn't work very well on Apple products, a common problem with many types of scientific computing software. Please see the GAMS website:
www.gams.com
I will also attach a guide for installing GAMS on Apple computers.

Likely method of assessment:

Exercises and problem sets:	40%	these must be done on time
Project:	40%	due at the time of the final exam
Class participation:	20%	ask interesting and challenging questions

The following are a list of topics for the lectures. For the reasons noted above, slides and exercises will be made up as we go along.

1. Installation of gams
   - installing on your laptop, **but please do this ahead of time**
   - installed on machines in the Economics Building computer lab (basement)
   - creating a project file and directory
   - running gams, reading output, debugging

2. Theory light: the Karush-Kuhn-Tucker theorem: Notes1

   fundamental result for optimization. Tells us we can convert a non-linear constrained optimization problem into a set of equations and inequalities in matched variables.

3. Example: profit maximization for a competitive firm
   - algebra: first-order condition, derivation of cost function

4. Simple syntax, introduction to the solvers using the profit-maximization problem

   NLP (non-linear programming, used in constrained optimization)
   MCP (mixed complementarity programming - for nxn systems of equations and inequalities in n bounded (e.g., non-negative) unknowns)
   MPEC (mathematical programming with equilibrium constraints) combines NLP and MCP:

   direct solution as an NLP (non-linear programming) problem
   solution using first-order condition as an MCP (mixed complementarity problem)
   example of MPEC: set a tax to maximize government tax revenue

5. Introduction to complementarity

   example of supply and demand: three types of solutions to two inequalities and unknowns with non-negative price and quantity
   correspondence between equations and unknowns
   use and interpretation of marginals (aka slack variables)

6. Brief presentation of the Newton method for solving nxn problems

7. Maximizing utility subject to a budget constraint

    formulated as an nlp
    formulated as an mcp using the KKT (first-order) conditions
    interpreting marginals as shadow values and Lagrangean multipliers
    deriving Marshallian demand functions
    deriving Hicksian demand functions, expenditure functon

8. Introduction to general equilibrium modeled as a complementarity problem: Notes2
    Intro2.pdf, Part B
    conditions for equilibrium: zero profits, market clearing, income balance
    micro consistency

9. A basic two-good, two-factor general-equilibrium model: Notes3
    model M21.gms
    assessing and interpreting counter-factuals

10. Variations on the basic model
    specific factors of production, income distribution
    slack activities; e.g., solar and wind power unprofitable at market prices
    labor-leisure choice
    two households with different preferences, income distribution

11. Industrial organization, games, operations research, econometrics: Notes4
    simple monopoly
    free entry and exit
    Cournot and Bertrand duopoly
    games with discrete strategies
    classic operations-research problem: logistics supply optimization
    classic econometrics problem: constrainted non-linear least squares as an NLP

11. Taxes, distortions, public goods and bads: Notes6
    benchmarking with taxes
    labor supply and distortionary income taxes
    equal-yield tax reform with endogenous labor-leisure choice
    modeling a public good
    endogenous, optimal provision of the public good
    modeling public infrastructure goods
    pollution externality

12. Open (trading) economy models: Notes8
    - modeling a small open economy
    - tariffs versus real trade costs
    - small economy with a benchmark tariff
    - quantitative restriction such as a quota
        - modeled as an endogenous tax equivalent
        - modeled as a license: an artificial commodity

Policies, Etiquette

E-mail policy: you may email me with small questions, but I tend not to answer questions that have been answered twice in class. *You are responsible for what is presented in class, including revisions to the syllabus and changes in mid-term dates.* Much of my communication with you will be via class email.

Class attendance policy: Since there is no textbook and we are making things up as we go along, class attendance is mandatory.

Athletics, clubs events, religion, weddings, etc. policy: all these things are known well ahead of time. If you have a conflict with an exam, tell me this week or forever hold your peace. I really have to insist that all absences including minor illnesses count as missed classes. That's the nature of this course.

If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and www.Colorado.EDU/disabilityservices Disability Services' letters for students with disabilities indicate legally mandated reasonable accommodations. The syllabus statements and answers to Frequently Asked Questions can be found at www.colorado.edu/disabilityservices

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Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at http://www.colorado.edu/policies/classbehavior.html and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

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