Course Content and Objectives

- The goal of this course is to prepare you for, or remind you of, the mathematical underpinnings of economic theory courses—Econ 606, 607, 608 and 609. To that end, we will seek to translate undergraduate economic theory topics into the language of mathematics, taking considerable care to develop the necessary mathematical framework and adding a few bells and whistles in the process. In addition, several increasingly important topics in economic theory are inherently mathematical—notably dynamic optimization models that form the basis of macroeconomic growth theory, natural resources exploitation models and other “dynamic” topics. We will cover both the mathematics and economics of these subjects, though only briefly.

- Ideally, we would cover each topic in this course just in time for the theory courses to use that topic. Inevitably, we will miss the timing on at least some topics. If the theory courses arrive at some topic that requires mathematics we have not yet covered in this course, you will nonetheless be expected to read mathematical appendices or other textbooks for that course to obtain at least an intuitive feel for the mathematics. Of course, you are also welcome to request adjustments in our schedule, and I will try to accommodate.

Prerequisites

MATH 203, MATH 215, MATH 241, MATH 251A or equivalent. Familiarity with the topics covered in the summer math cram course (offered by the Department of Economics).

Grading

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<th>Component</th>
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<tr>
<td>Problem Sets</td>
<td>30%</td>
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<tr>
<td>In-class quiz (September 11)</td>
<td>10%</td>
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<tr>
<td>Midterm</td>
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<td>Final Exam (December 11)</td>
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There will be periodic problem sets. The problem sets will be mostly analytical but may also include some numerical problems. The latter type may involve the use of Excel or Matlab on the
computer. I encourage you to work together on problem sets but each of you will hand in your own assignment.

**Textbooks**
There are two books that we will reference fairly extensively in the course:

**Other references**

**Calculus and its applications to economics**
*(Sundaram’s book is also highly recommended.)*

**Dynamic programming**

**Optimal control theory**

**Analysis**

**Numerical methods**
Topics covered

1. Preliminaries
   Elements of set theory, logic, and proof
   *SB Appendix A1
   Sundaram Appendices A and B

   Properties of Euclidean space and metric space
   Sequence, convergence and limits, Cauchy sequence, vector space, norm, metric space, complete metric space, Banach space
   *SB Ch 10 and 12.1, 12.2
   *SLP Ch 3.1
   Sundaram, Ch 1.1 and 1.2
   Sundaram, Appendix C

   Topology of Euclidean spaces
   Open, closed, bounded, compact sets
   *SB Ch 12.3-12.6, Ch 29.

2. Multivariate calculus
   Functions: basic concepts
   Basic terminology of functions, continuity, monotonicity, partial and total derivatives, chain rule, higher order derivatives
   *SB Ch 13, 14.1-14.9
   Sundaram, Ch 1.4

   Functions: applications
   Intermediate and mean value theorems, Taylor’s Theorem, inverse and implicit function theorem
   *SB Ch 15, 30
   Sundaram, Ch 1.5 and 1.6

   Existence of solutions to optimization
   Weierstrass Theorem
   *SB Ch 30.1
   Sundaram, Ch 3

3. Static optimization
   Unconstrained optimization
   Quadratic forms, first order necessary conditions, second order sufficient conditions
   *SB 16.1, 16.2, 17
   Sundaram, Ch 4
Constrained optimization
Lagrangian method, first order necessary conditions, second order sufficient conditions, equality and inequality constraints, Kuhn-Tucker Theorem, interpretation of Lagrangian multipliers, envelope theorems, concave and quasiconcave functions, concave programming
Sundaram, Ch 5, 6, 7, 8

Economic applications of static optimization
Utility maximization and expenditure minimization, Roy’s identity, Shephard’s lemma, Slutsky matrix
*SB Ch 22

4. Dynamic optimization
Difference and differential equations
*Difference equation: SB 23.1, 23.2

Dynamic optimization: Calculus of variations, optimal control theory
The Calculus of Variations: Chiang Ch 2, 3, 6
The Hamiltonian Function: Chiang Ch. 7
More on Optimal Control: Chiang Ch 8
Infinite-Horizon Problems: Chiang Ch 5, 9

5. Other possible topics
Parametric continuity, the Maximum Theorem, Fixed Point Theorem
Sundaram, Ch 9

Exam schedule
An in-class quiz is scheduled on Sep. 11 (Tuesday), followed by a TA session on Sep. 13 (Thursday). The midterm exam is scheduled after the section on static optimization. The final exam is scheduled at 12:00-2:00 pm on Dec. 11 (Tuesday).

Disability Access
If you feel you need reasonable accommodations because of the impact of a disability, please: (1) contact the KOKUA Program (V/T) at 956-7511 or 956-7612 in room 013 of the QLCSS (Queen Lili‘uokalani DCenter for Student Services); (2) speak with me privately to discuss your specific needs. I will be happy to work with you and the KOKUA Program to meet access needs related to a documented disability.