Learning Objectives

- Gains understanding about the mathematical underpinnings of economic theory courses—Econ 606, 607, 608 and 609.
  - Understand how to apply optimization methods to solve static problems.
  - Understand how to apply dynamic optimization methods.
- Be able to follow theoretical discussions in economics journal articles.
  - Become familiar with the methods of basic mathematical proofs and other real-analysis tools that are and methods.

In order to develop solid mathematics background necessary for the subsequent coursework and dissertation research, we will seek to translate undergraduate economic theory topics into the language of mathematics, taking considerable care to develop the necessary mathematical. In addition, several increasingly important topics in economic theory are inherently mathematical—namely dynamic optimization models that form the basis of macroeconomic growth theory, natural resources economics 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).

It is strongly recommended that you take Econ 606 (Microeconomic Theory I) concurrently (see “Schedule” below).
Schedule
Econ 627 covers many mathematical concepts and tools that are useful in Econ 606 and 607. For this reason, we plan to use Econ 606’s lecture time in the first several weeks for lectures in Econ 627—that is, to frontload Econ 627 (using the lecture time for both 606 and 627 in the beginning of the semester) and then focus on Econ 606 later on in the semester. Based on the existing Econ graduate students’ experience, we believe that this arrangement would best suit the first-year students’ interest. For this lecture arrangement to work, it would be best if an identical set of students take both Econ 606 and 627. For your information, the following was the schedule for last Fall semester in 2015.

<table>
<thead>
<tr>
<th>Time</th>
<th>Room</th>
<th>12:00-1:15</th>
<th>1:30-2:45</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Aug 25</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Aug 27</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Sep 1</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Sep 3</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Sep 8</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Sep 10</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Sep 15</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Sep 17</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Sep 22</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Sep 24</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Sep 29</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Oct 1</td>
<td>606</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Oct 6</td>
<td>606</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Oct 8</td>
<td>606</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Oct 13</td>
<td>606</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Oct 15</td>
<td>606</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Oct 20</td>
<td>606</td>
<td>627</td>
</tr>
<tr>
<td>R</td>
<td>Oct 22</td>
<td>606</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Oct 27</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>R</td>
<td>Oct 29</td>
<td>627</td>
<td>627</td>
</tr>
<tr>
<td>T</td>
<td>Nov 3</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>R</td>
<td>Nov 5</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>T</td>
<td>Nov 10</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>R</td>
<td>Nov 12</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>T</td>
<td>Nov 17</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>R</td>
<td>Nov 19</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>T</td>
<td>Nov 24</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>R</td>
<td>Nov 26 Thanksgiving Thanksgiving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Dec 1</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>R</td>
<td>Dec 3</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>T</td>
<td>Dec 8</td>
<td>606</td>
<td>606</td>
</tr>
<tr>
<td>R</td>
<td>Dec 10</td>
<td>606</td>
<td>606</td>
</tr>
</tbody>
</table>

Grading
Problem Sets: 30%
Midterms (2): 40% (20% each)
Final Exam (Thursday Oct 29 12:00-14:00): 30%
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. **Though you are encouraged to work in groups, you must acknowledge your collaborators in your solutions to the problem sets.**

**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 calculus
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

MIDTERM I

3. Static optimization
Unconstrained optimization
Quadratic forms, first order necessary conditions, second order sufficient conditions
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

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

MIDTERM II

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
Maximum Theorem, Fixed Point Theorem, …

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.