## Organization:

The class meets from 9:00 to 10:50 every weekday from Monday, August 27 through Friday, September 14. There is no class on Monday, September 3 (Labor Day). On most days from 11:00-11:50 there will be a supplementary session to discuss and work assigned problems. All class meetings are in Room 300 in the Economics Building. I will also be available in my office, Room 311, after class.

## Objective

This course is a rapid overview of topics in calculus, advanced calculus, linear algebra, and optimization that are relevant to economic theory. I hope that it provides the necessary mathematical background to begin the core graduate sequence. The course covers a large amount of material at a relatively high level of rigor. If it has been a long time since you have used calculus, then the course will be difficult. If you have never used calculus, then the course may be impossible.

## Requirements:

The main evaluation will be a three hour, closed book, closed notes examination currently scheduled for Monday, September 17 from 9:00 to 12:00. If you take the course for credit, your grade will be the maximum of your grade on the final examination, and a weighted average of your final exam grade $(75 \%)$ and your performance on quizzes. If you do not take the class for credit, then you must still pass the final examination in order to enroll in Economics 200A.

Problems are a necessary part of learning the material. I have placed on reserve copies of relevant problems from a basic calculus book by Apostal, Chiang's book on mathematics for economists, and an vector calculus book by by Marsden, Tromba, and Weinstein. These problems mostly cover elementary material. You may want to concentrate on these problems if you are having difficulty with the course material. Relevant problems are also available in the texts. I attach a list of problems that are related to each topic. You should conscientiously attempt to do them throughout the course.

## Texts and Reference Material:

(SB) C. Simon and L. Blume, Mathematics for Economists
(N) W. Novshek, Mathematics for Economists
(D) A. Dixit, Optimization in Economic Theory, 2nd edition
(MA) K. G. Binmore, Mathematical Analysis
(C) K. G. Binmore, Calculus
(CH) A. Chiang, Fundamental Methods of Mathematical Economics
(SB) should be available in the University Bookstore. Copies of all books are on reserve in the departmental library (Economics 304).

There are many books that cover the basic material of this course. Feel free to use another book as a primary reference. (If you are not sure whether another book is adequate, then check with me.)
(SB) is officially the text for the course. It has the following strengths: it contains many economic examples; it covers the topics that I intend to cover; it covers other material (for example, linear algebra) that you should know; it has many problems and solutions. On the other hand, it is poorly organized and its level of treatment is uneven. My lectures will be quite different from the text material. (N) is concise, covers most of the topics, and has many problems and solutions. Its coverage of one-variable calculus is brief and its approach to optimization is mechanical. (D) is a nice introduction to optimization from the perspective of economics. (MA) is a concise introduction to "advanced" one-variable calculus. It presents definitions and theorems with care and provides an introduction to proofs. It is slightly more advanced than the course will be. It may be a good place to look if the material in the first week seems to easy. (C) is more basic than (MA). It has reasonable coverage of most of the topics of multi-variable calculus. (CH) is a standard reference for courses in mathematics for economists, but I find it too mechanical. It may be a good place to look if the lectures seem difficult.

## Topical Outline and References:

The table lists the topics that I hope to cover. It relates the topics to pages in the five texts mentioned above. The number of pages devoted to each topic varies drastically from text to text. The quality and the level of treatment vary as well.

| Topic |  | Ch | MA | C | N | SB |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | Basic Concepts | 132-44 | 1-48;65-84 |  | 1-2; 36-42 | 3-9; 847-57 |
| 1 | Continuity | 145-49 | 85-91 |  | 2-3; 42-44 | 10-21 |
| 2 | Differentiability | 128-32;149-74 | 92-100 |  | 3-5 | $\begin{aligned} & 22-34 ; 39- \\ & 42 ; 70-4 \end{aligned}$ |
| 3 | Mean Value Theorems | 254-62 | 101-8 |  | 5-6 | 822-32 |
| 4 | Extrema, Concavity |  |  |  |  | 43-6; 51-69 |
| 5 | Vectors | 54-87 |  | 1-32 |  | $\begin{aligned} & 199-204 ; 209- \\ & 30 \end{aligned}$ |
| 6 | Linear Algebra: Basics |  |  |  |  | $\begin{aligned} & 153-73 ; 237- \\ & 49 \end{aligned}$ |
| 7 | Eigenvalues |  |  |  |  | $\begin{aligned} & 188-94 ; 579- \\ & 84 ; 601- \\ & 7 ; 609-15 \end{aligned}$ |
| 8 | Quadratic Forms |  |  |  |  | $\begin{aligned} & 375-86 ; 398- \\ & 404 ; 620-32 \end{aligned}$ |
| 9 | Vector Calculus | 169-78 |  | 39-59 | 56-70 | $\begin{aligned} & 273-95 ; 301- \\ & 5 ; 313-28 \end{aligned}$ |
| 10 | Multi-variable MVT |  |  | 101-29 | 70-73 | 328-32;832-6 |
| 11 | Unconstrained Optimization | 231-54; 307-68 |  | 149-54 | 6-7; 73-77 | $\begin{aligned} & 375-86 ; 396- \\ & 410 \end{aligned}$ |
| 12 | Implicit Functions | 184-86;204-27 |  | 161-211 | 133-46 | 334-64 |
| 13 | Equality Constraints | 369-432 |  | 85-95 | 77-103 | $\begin{aligned} & 411-23 ; 478- \\ & 80 \end{aligned}$ |
| 14 | Inequality Constraints | 688-755 |  | 131-35 | 111-127 | 424-78;480-2 |

Dixit contains material relevant to the optimization topics.

## Guide to Recommended Problems:

The table below indicates some problems that correspond to the material that I will cover. The problems in $\mathrm{Ch}, \mathrm{C}$, and N are the most mechanical. D's problems are conceptual. The problems in MA are typically proofs. Remember that in addition to these problems there are supplementary problems, and problems from various books on reserve. Novshek's book has more relevant problems than those listed above. Dixit's book contains extended exercises motivated by economic models at the end of each chapter.

| Topic 1 | Ch | $\begin{gathered} \text { MA } \\ 21: 1-3 ; 36: 1-3 ; \\ 40: 1-5 ; 73: 1-3 \end{gathered}$ | C | N | $\begin{gathered} \text { SB } \\ 15: 1,4 ; 21: 7-9 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 2 |  | 81:1-5;90:1 |  |  | $\begin{aligned} & 29: 11 ; 12 ; 32: 15, \\ & 16 ; 42: 1 ; 74: 1,6 \end{aligned}$ |
| 3 |  | 98:1,3 |  |  | 832:7,8 |
| 4 | $\begin{aligned} & 74: 1-3,5,7 \\ & 177: 1,2,5 \end{aligned}$ | 104:1-4 |  | 106:1-7 | 47:4,5; 58:11 |
| 5 |  |  | 30:1-13 |  | $\begin{aligned} & \text { 204:1- } \\ & 3 ; 220: 10,11,13 ; 2 \\ & 25: 27- \\ & 31 ; 230: 32,38-40 \end{aligned}$ |
| 6 |  |  |  |  | $\begin{aligned} & 160: 3,243: 2 ; 246: \\ & 9,10 ; 249: 14 \end{aligned}$ |
| 7 |  |  |  |  | $\begin{aligned} & \text { 584:1,2,4,5;608: } \\ & 16 ; \end{aligned}$ |
| 8 |  |  |  |  | $\begin{aligned} & 386: 1,2 ; 402: 1,2 \\ & 625: 37-39 \end{aligned}$ |
| 9 | 214:1-5 |  | 58:7-12 | 184:2-5,8,10 | $\begin{aligned} & 295: 17,21 ; 302: 1, \\ & 2 ; 318: 11,13 ; \\ & 322: 18,20 \end{aligned}$ |
| 10 | 730:1-6;738:1-5 |  | 129:11,12 | 127:1-36 | $\begin{aligned} & 332: 24,28 \\ & 836: 13,14 \end{aligned}$ |
| 11 |  |  | 92:1-16 |  | 402:1,2 |
| 12 |  |  | 207:1,2,4,6-10 |  | $\begin{aligned} & 342: 6,8 ; 350: 13 \\ & 358: 18,21,22 \end{aligned}$ |
| 13 |  |  | 245:8-12,15-16 |  | 423:2,4,5,7 |
| 14 | 446:1-5 |  | 92:1-16 | 21:1-3 | $\begin{aligned} & 434: 10-12 \\ & 436: 15 ; 453: 3-5 \end{aligned}$ |

