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University of California, Davis **Department of Agricultural Economics** **Department of Economics**

MATH CAMP 2011
Lectures in Mathematical Methods

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Math Camp is designed to maintain or develop familiarity with the mathematical tools used in the Ph.D. Microeconomic Theory sequence 200 A-C. It requires a substantial amount of homework: exercises and problem solving. There is neither formal registration nor a grade, but problems will be assigned for review and correction.

BOOKS

REQUIRED TEXTBOOKS: (you should buy them and spend time with them; available at the UCD Bookstore).

1. A. Mas-Colell, M. D. Whinston and J. R. Green (1995) *Microeconomic Theory*, New York: Oxford University Press ("M-C *et al*." in what follows). This is the basic textbook for the Microeconomic Theory sequence; the Math Camp syllabus follows its Mathematical Appendix: think of the Appendix as the skeleton for Math Camp, with the flesh provided by the lectures and our next book.

2. C. P. Simon and L. Blume (1994) *Mathematics for Economists*, New York: Norton ("S&B" in what follows). Covers in detail much of the Math Camp material, as well as most of the background math on which Math Camp rests.

OTHER BOOKS

(Totally optional: there is no need to read them, but you may want to check if you are already familiar with any of them, or if you are interested in alternative presentations.)

Chiang, A. (1984) *Fundamental Methods of Mathematical Economics,* 3rd. Edition, New York: MacGraw-Hill.

Dixit, A. K. (1990) *Optimization in Economic Theory,* 2nd Edition, New York: Oxford University Press.

Madden, P. (1986) *Concavity and Optimization in Microeconomics*, Oxford: Basil Blackwell.

Novshek, W. (1993) *Mathematics for Economists*, San Diego: Academic Press.

Silberberg, E. (1990) *The Structure of Economics: A Mathematical Analysis*, 2nd Edition, New York: MacGraw-Hill.

Sydsaeter, K. and P. J. Hammond (1995) *Mathematics for Economic Analysis*, Englewood Cliffs, NJ: Prentice Hall.

Takayama, A. (1985) *Mathematical Economics*, 2nd Edition, Cambridge: Cambridge University Press.

MATH BACKGROUND

Math Camp presupposes a sound understanding of univariate calculus and elementary linear algebra, and an operational familiarity with its tools.

S&B is a good tool for reviewing and refreshing this material (you may also benefit from the books that you have used in the past). Roughly speaking, you should know the contents of chapters 1 to 9 and 11 by the time that Math Camp starts. More specifically, please make sure that you master the following material.

Sets, Numbers, Proofs:	S&B, Appendix A1.
One-variable calculus:	S&B, Chapter 2 (all), S&B, Chapter 3, Sections 3.1 to 3.4, S&B, Chapter 4 (all), S&B, Appendix A.4.
Probability:	S&B, Appendix A.5.
Exponents and logarithms:	S&B, Chapter 5 (all).
Linear algebra:	S&B, Chapter 6, Section 6.1, S&B, Chapter 7, Sections 7.3 and 7.4, S&B, Chapter 8, Sections 8.1, 8.2, 8.4 and 8.6, S&B, Chapter 9, Sections 9.1 and 9.2, S&B, Chapter 11 (all).

If some stuff is rusty, forgotten or new to you, you should spend time early in the Camp studying it and doing the problems. Check with us if you need help.

On the other hand, Section 3.5 of Chapter 3, and chapters 10, 12 to 21 and 30 of S&B will be covered in more or less detail during Math Camp.

SYLLABUS

Note. An asterisk " * " means that the answer to the exercise can be found at the end of S&B.

1. Vectors in R^N; Functions from R^N to R^M; Level Sets and Level Curves. Definite Forms

Reading: S&B: Ch. 10, in particular pp. 199-231
S&B: Ch. 13, Sections 13.1-3 and 13.5.
S&B: Ch. 16, in particular pp. 375-392
M-C *et al*.: Mathematical Appendix, Section M.D
Handouts.

Exercises: Problem Set # 1
S&B: p. 208: 10.5 *; 10.6
S&B: p. 220-221: 10.10*; 10.11*; 10.12*; 10.15*; 10.20; 10.22
S&B: p. 225: 10.27
S&B: p. 286: 13.3, 13.6, 13.7.
S&B: p. 292: 13.11*, 13.12*.
S&B: p. 386: 16.1*, 16.2
S&B: p. 392: 16.6*.

Optional reading Madden, Ch. 4, pages 55-58
Sydsaeter-Hammond, Ch. 17, pages 632-641.

2. Continuous Functions from R^N to R^M; Compact Sets

Reading: M-C *et al*.: Mathematical Appendix, Section F.
S&B: Ch. 12 & 13.

Exercises: Problem Set # 2
S&B: p. 259: 12.1*, 12.2*, 12.6, 12.9
S&B: p. 267: 12.14, 12.15, 12.16
S&B: p. 269-270: 12.18, 12.20, 12.21*, 12.27
S&B: p. 272: 12.29, 12.30, 12.31
S&B: p. 286: 3.7
S&B: p. 292: 13.12*
S&B: p. 299: What is wrong with the wording of the question in problem 13.23?
S&B: p. 299: 13.24.

Optional reading Novshek, Ch. 3, pages 36-43

3. Differentiable Functions from R^N to R^M. The Chain Rule

Reading: Handout on differentiable functions
M-C *et al*.: Mathematical Appendix, Section M.A
S&B: Ch. 14.

Exercises: Problem Set # 3
S&B: p. 302: 14.1*, 14.2*
S&B: p. 307: 14.4*, 14.5*

S&B: p. 318-319: 14.11*, 14.12* (note: here "rates" mean time rates, i. e., change in absolute terms per unit of time), 14.13*.
S&B: p. 322-323: 14.18*; 14.19*; 14.20*
S&B: p. 328:14.22*
S&B: p. 332:14.23*, 14.28.

Optional reading Novshek, Ch. 5, pages 56-69
Silberberg, Ch. 3, pages 68-84
Sydsaeter-Hammond, Ch. 15, pages 489-549.

4. The Implicit Function Theorem

Reading: M-C *et al.*: Mathematical Appendix, Section M.E.
S&B: Sections 15.1 to 15.4.

Exercises: Problem Set # 4
S&B: p. 342: 15.1, 15.6*; 15.8*, 15.9*. What is the precise meaning of the word "estimate" as used in these problems?
S&B: p. 350: 15.10, 15.11, 15.12
S&B: p. 358-359: 15.15*, 15.18*, 15.19*, 15.20*, 15.22*, 15.23*.

Optional reading Madden, Ch. 17, pages 261-263
Sydsaeter-Hammond, Ch. 5, pages 154-166, Ch. 16, pages 550-558.

5. Homogeneous and Homothetic Functions

Reading: M-C *et al.*: Mathematical Appendix, Section M.B.
S&B: Ch. 20, pages 483-492.

Exercises: Problem Set # 5
S&B: p. 493: 20.1*; 20.2, 20.3, 20.4
S&B: p. 499: 20.9*, 20.10, 20.11*, 20.12*, 20.13, 20.14*, 20.15
S&B: p. 504: 20.16, 20.17*, 20.18*.

Optional reading Chiang, Ch. 12, pages 410-417
Madden, Ch. 9, pages 114-127
Sydsaeter-Hammond, Ch. 16, pages 565-573.

6. Convex Sets and Concave Functions

Reading: M-C *et al.*: Mathematical Appendix, Sections M.C, M.D (examples) and M.G (partially) .
S&B: Sections 21.1, 21.2 & 21.3.

Exercises: Problem Set # 6
S&B: p. 516: 21.1, 21.2*, 21.7
S&B: p. 527: 21.18*, 21.21
Use the bordered Hessian test to check the quasiconcavity of the functions in 21.23*.

Optional reading Chiang, Ch. 12, pages 387-399
Madden, Ch. 7, pages 86-100, Ch.13, pages 193-213
Novshek, Ch. 5, page 95-102
Sydsaeter-Hammond, Ch. 17, pages 618-649.

7. Unconstrained Maximization: the Solution Correspondence and the Value Function

Reading: M-C *et al.*: Mathematical Appendix, Section M.J.
S&B Ch. 17.

Exercises: Problem Set # 7
S&B: p. 402: 17.1*, 17.2*.
S&B: p. 404: 17.3*.

Optional reading Chiang, Ch. 9, pages 213-267
Sydsaeter-Hammond, Ch. 17, pages 596-617.

8. Constrained Maximization: the Kuhn-Tucker Theorem

Reading: M-C *et al.*: Mathematical Appendix, Section M.K.
S&B Ch. 18, Sect. 19.1, Sect. 19.3.

Exercises: Problem Set # 8
S&B: p. 423: 18.1, 18.2*, 18.3*, 18.5*, 18.6*, 18.7*, 18.8
S&B: p. 434: 18.10*, 18.11*, 18.12, 18.13
S&B: p. 439: 18.16, 18.17*
S&B: p. 469: 19.14*.

Optional reading Chiang, Ch. 12, pages 369-386.
Dixit, Ch. 2, 3 and 4, pages 10-54, and Ch. 7 and 8, pages 87-121
Madden, Ch. 5, pages 60-74, Ch.19, pages 275-284
Novshek, Ch. 6, page 111-131
Silberberg, Ch. 6, pages 156-189, Ch. 14, pages 462-490
Sydsaeter-Hammond, Ch. 18, pages 650-677.

9. The Envelope Theorem

Reading: M-C *et al.*: Mathematical Appendix, Section M.L.
S&B Sect. 19. 2

Exercises: S&B: p. 457: 19.12*, 19.13*

Optional reading Dixit, Ch. 5, pages 55-68
Madden, Ch. 8, pages 101-113
Novshek, Ch. 6, pages 149-157, Ch. 8, pages 182-184
Silberberg Ch. 7, pages 190-204
Sydsaeter-Hammond, Ch. 18, pages 678-690.