Syllabus for Econ 897
Summer 2014

Instructors:
Juan Hernandez (Part I, email: juanhern@sas.upenn.edu)
Ju Hu (Part II, email: juhu1@sas.upenn.edu)
Yunan Li (Part III, email: yunanli@sas.upenn.edu)

Schedule:
July 14 - August 21, 2014: Monday, Tuesday, Wednesday, Thursday and Friday
Time: 10:00 AM-12:00 noon and 1:30 PM-3:30 PM each day
Final (Waiver) Exam: Monday, August 24, 2014
Location: TBA

Course Website: http://economics.sas.upenn.edu/graduate-program/current-students/course-information/summer-math-camp

Textbooks:
There are three textbooks for this course.

• For real analysis,
• For optimization,
• For probability,
  Statistical Inference by Casella and Berger (CB), Thomson Learning 2002. This one will be
  used again in ECON 705.

In addition, you might find some of the following books useful to supplement different parts of
the lectures.

The classic Principles of Mathematical Analysis by Walter Rudin is a good reference. You
can also have a look at the first chapters of The Nature and Origins of Modern Mathematics: an

If you are not familiar with the elementary set theory and structure of proofs, we strongly suggest that you read the section 1.1 in Pugh.

**Exams and Homework:**

There will be graded tests every Friday to cover the materials covered in the corresponding week. These two tests will be graded. Additionally, each instructor might give quizzes and will post problem sets. These might influence your grade as well. We strongly recommend you to try to solve the questions before you see solutions. The waiver exam is the final for all three parts of Econ 897. Your grade will be determined as the average of your grades for all three parts.
Outline of the Course:

Part I. Weeks 1 and 2

(a) The Real Numbers
   i. Properties of $\mathbb{R}$. (Pugh, §1.2)
   ii. Euclidean Space (Pugh, §1.3)
   iii. Functions and Cardinality (Pugh, §1.4)
   iv. The Skeleton of Calculus (Pugh, §1.6)

(b) Metric Spaces and Very Basic Topology (Pugh, §2.1)
   i. Metrics, Sequences, Convergence and Limits
   ii. Closed and Open Sets, Accumulation Points, Boundaries, Closure
   iii. Topological Continuity and Homeomorphisms
   iv. Cauchy Sequences and Completeness
   v. Topological and Sequential Limits
   vi. Continuity of Correspondences (Sundaram, §9.1; MWG, Appendix M.H)

(c) Compactness and Connectedness
   i. Sequential Compactness (Pugh, §2.2)
   ii. Heine-Borel and Weierstrass Theorems (Pugh, §2.2)
   iii. Extreme Value Theorem (Pugh, §2.2)
   iv. Connectedness (Pugh, §2.3)
   v. Coverings (Pugh, §2.4) [If time permits]

Part II. Weeks 3 and 4

(a) Differentiation: (Pugh, §3.1)
   i. Definition and basic properties
   ii. Mean value theorem and inverse function theorem
   iii. Higher order derivatives and Taylor’s theorem

(b) Linear Algebra:
   i. Determinants (Sundaram, §1.3; Pugh, Chapter 5 Appendix E)
ii. Vector spaces and linear mappings (Sundaram, Appendix C.1; Pugh §5.1)

iii. Inner product and orthogonality (Sundaram, Appendix C.2)

(c) Analysis in $\mathbb{R}^n$:

i. Partial and total derivatives (Pugh, §5.2)

ii. Higher derivatives (Pugh, §5.3)

iii. Implicit and inverse functions (Pugh, §5.5)

iv. Convex Sets and Separating Hyperplane Theorems (MWG, Appendix M.G)

v. Concavity and Quasi-Concavity (Sundaram, §7.1-7.2 and §8.1-8.3)

Part III. Weeks 5 and 6

(a) Optimization Theory in $\mathbb{R}^n$:

i. Definitions and the Basic Setup (Sundaram, §2.1-2.4)

ii. Characterization of Optimal Solutions

- Unconstrained Optimization Problems (Sundaram, §4.1-4.6; MWG, Appendix M.J)
- Equality Constraints and the Theorem of Lagrange (Sundaram, §5.1-5.7; MWG, Appendix M.K)
- Inequality Constraints and the Theorem of Kuhn-Tucker (Sundaram, §6.1-6.5; MWG, Appendix M.K)
- Concavity and Quasi-Concavity in Optimization (Sundaram, §7.3-7.4 and §8.3-8.5)

iii. Sensitivity

- The Maximum Theorem (Sundaram, §9.2)
- The Envelope Theorems (MWG, Appendix M.L)

(b) Brief Review of Basic Probability Theory

i. Basics of Probability Theory (CB, §1.1-1.2)

ii. Random Variables (CB, §1.4)

iii. Transformations, Expectations and Moments (CB, §2.1-2.2)

iv. Common Families of Distributions

- Discrete Distributions (CB, §3.2)
• Continuous Distributions (CB, §3.3)

v. Multiple Random Variables
• Joint and Marginal Distributions (CB, §4.1)
• Conditional Distributions and Independence (CB, §4.2)
• Multidimensional Transformations (CB, §4.3)

vi. Convergence Concepts
• Convergence in Probability (CB, §5.5.1)
• Convergence in Distributions (CB, §5.5.3)