Instructors:	Patrick Holder and Chris Severen
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Classroom:	North Hall 2XXX
Meetings:	August 31st – September 18th: M-F 10am - 11:30am, 1pm-2:30pm (2x day)
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Office Hours:	TBD

Course Description

PhD Math Camp is designed to bridge material you encountered during undergraduate preparation and new technical skills that will be covered extensively in the first year PhD sequence. The focus of the class is on mathematical concepts and tools useful in your first year classes and more generally during your career as an economist. Though some topics may be familiar to some students, this course seeks to approach topics with an economic mindset and oriented to how this material is applied in first year classes.

The course assumes that you have taken multivariate calculus, basic linear algebra, and have familiarity with basic probability and statistics. Brief reviews of these subjects will be provided, but will be motivated by how these topics are useful within the economics profession (preference theory, optimization, econometrics, etc). The course will also cover topics from real analysis, set theory, optimization, and other relevant fields.

The course will be split by subject:

- *Class A (Mornings)*: Probability, Statistics, Linear Algebra, Programming, Econometrics
- *Class B (Afternoons)*: Logic, Set Theory, Analysis, Calculus, Optimization

Assignments and Workload

This course provides you with a review of concepts which you have previously encountered and introduces new (and useful) concepts. In order to (re-)familiarize yourself with these concepts, we will provide exercises for the topics covered in class (see Topic List). These exercises are optional, and it is not necessary to do all problems. Pace yourself and understand what is helpful to you.

For problems drawn from books, we will try to provide the source. You are encouraged to use answer guides (which are often available online) to *check* your work. We may or may not provide answers to some or all exercises.

There is a reason to format the class in this manner: You have to pass your first year classes. To do this, you must learn how to teach yourself various concepts and balance your workload. You need to understand when you are fluent with a particular concept, so that you can move on to other items (there is *always* something else to study). We give you a lot of problems to provide a resource for learning these concepts, but also to urge you to begin evaluating your own comfort with the material and then adjust your learning strategy accordingly.

Evaluation

There is no grade for this class. In no way will any results from this class affect your success in the program. This class is provided as a tool to you, and will be entirely what you make of it.

Source Materials

Course material (including lectures, notes, and problems) will be drawn from the following list. You are ***not required to purchase any of these materials***! However, we will discuss some recommendations for purchases below.

- (CAR) Carter, Michael. *Foundations of Mathematical Economics*. MIT Press, 2001.
- (JR) Jehle, Geoffrey A., and Philip J. Reny. *Advanced Microeconomic Theory*. Prentice Hall (several editions). (Appendices)
- (MWG) Mas-Colell, Andreu, Michael Whinston, and Jerry Green. *Microeconomic theory*. Oxford University Press, 1995. (Appendices).
- (ROS) Rosenlicht, Maxwell. *Introduction to Analysis*. Dover, 1968 (rep. 1985).
- (SB) Simon, C.P. and L.E. Blume. *Mathematics for Economists*. Norton, 1994.
- (VEL) Velleman, Daniel J. *How to Prove It: A Structured Approach.* Cambridge University Press, 2006.

. . . and of course, Wikipedia. we will drawing primarily from (SB) and (CAR). (SB) is a good book to own as a reference source and draws from a broad array of theoretical topics with quite a few exercises. (CAR) is bit more analytical and has long chapter on optimization and more serious treatment of sets, orders, and other concepts which may be useful for theoretical microeconomics.

If you would like more practice with logic, proofs, and set theory, (VEL) is great. You can find it fairly cheaply online. (ROS) is a very good (and very cheap) source for real analysis, used extensively by Maths departments. We like this book and its exercises a lot.

For your first micro class, you will be required to purchase (JR). This is a good graduate level text on microeconomic theory that explains core concepts nicely. The appendices contain a review of useful mathematics and exercises. If you are pondering any sort of micro theory, you will at some point purchase (MWG). This is the standard reference for microeconomics, and you may need it for some of your first-year micro classes. However, it is expensive and gigantic.

Topic List (Tenative)

The following is a rather ambitious list of topics from which lectures and assignments will be drawn. All of the topics may be useful at some time, however, extensive knowledge of each item is not necessary. We will focus lectures on the topics that you will see most often and will be most useful to you; less important topics will be mentioned in passing.

	Class A: Matrices & Statistics	**Class B: Analysis & Optimization**
Week 1 (5 classes)	Linear Algebra I: *Notation, Operations, Singularity & invertability, Determinants, Quadratic forms* Linear Algebra II: *Eigenvalues & eigenvectors, Vector & matrix differentiation, (Semi) definiteness, Common decompositions, Diagonal dominance* Proof Practice: *Linear algebra based proofs*	Logic: *Notation, An introduction to writing proofs, Truth tables* Set Theory: *Notation, Operations, Proofs, Cardinality, Functions & correspondences, Abstract algebra*
Week 2 (4 classes)	Econometric Review: *OLS, OLS with matrices, Hypothesis testing* Programming: *Concepts, Intro to Stata, Intro to Matlab, Style, Simulations, Applications to econometrics, Applications to linear algebra* Basic Measure Theory: *Measures, Measurable functions, etc*	Real Analysis: *Proofs, Continuity, Closure, Boundedness, Compactness, Set convexity* Convex Analysis: *Convexity & concavity, Quasiconvexity & quasiconcavity, Hessians & Bordered Hessians, Jacobians, Principle minors, (Semi) definiteness and its applications to convex analysis*
Week 3 (5 classes)	Probability Theory: *Algebras, Borel sets, Sets & events, Probability Space, Random variables, Bayes' Law, Conditioning* Statistics: *Functions of random variables, PDFs, PMFs, CDFs, Bivariate distributions, Conditional & marginal distributions, Common distributions, Moments, Statistical inference*	Unconstrained Optimization: *Maxima and minima, critical points & inflection points* Constrained Optimization: *Equality & inequality constraints, Lagrangians, Kuhn-Tucker theorem, Shadow values, Envelope theorem, Optimal control*