Logistics

*Instructor:* Atara Oliver, sao5@rice.edu  
*Scheduled:* October 24 - November 18, MTWThF, 20 Lectures  
*Time:* 2-hour Online Lecture MTWThF  
*Location:* Canvas Platform, https://canvas.rice.edu  
*Office Hours:* 8pm-9pm MW, 11:00 AM - 12:00 PM TTh

Course Outline

The aim of this course is to introduce/remind you a basic level of mathematics which is required for the Ph.D. courses in economics. Specifically, in this course, we will learn/remember standard tools and cookbook procedures that are required for the first year Ph.D. courses.

I divide the lecture into five parts: Real Analysis, Linear Algebra, Calculus, Optimization and Difference & Differential Equations. There will be two homeworks for each part. I will ask questions to be answered during the online lectures to measure your attendance. You should expect to study three hours on average for reviewing the material and doing the homeworks. In addition, there will be daily office hours twice a day. The attendance to the office hours is not mandatory but highly encouraged. I will be available to answer your questions and you will have opportunity to interact with your classmates.

There will be an exam at the end of the course. The weights of the attendance to the lectures, quizzes, homeworks, and the exam are 10%, 20%, 20%, and 50% respectively. In order to keep up with the course, it is essential that assignments be turned in on time. Therefore, to help maintain the pace of the course, there will be a penalty for late assignments. I will take off 10% of the total assignment grade for each day an assignment is late for the first five calendar days (with a minimum possible assignment grade of 0), and will not accept assignments turned in more than five days late.
General Readings:


I. Real Analysis (Lectures 1-4)

(a) Sets:

- Algebra of Sets
- Families of Sets
- Cartesian Product
- Binary Relations and Ordered Sets, Supremum and Infimum
- Functions and Correspondences

Recommended Readings:


(b) Metric Spaces:

- Metric Spaces, Euclidean Spaces
- Topological Properties of Sets: Open, Closed, Compact, Dense and Connected Sets; Interior, Closure and Boundary of Sets
- Topological Properties of Sequences: Convergence, Subsequences, Cauchy Sequences, Upper and Lower Limits, Complete Metric Space, Series and Absolute Convergence
- Topological Properties of Functions and Correspondences: Continuity, Upper and Lower Semicontinuity
- Continuity, Compactness and Connectedness

**Required Readings:**


### II. Linear Algebra (Lectures 5-9)

(a) Linear Algebra:

- Vectors, Vector Operations
- Linear Dependence
- Basis, Vector Spaces and Subspaces
- Matrices and Matrix Algebra
- Inner Product and Projection
- Linear Transformations
- Rank and Determinant
- Solutions to Systems of Linear Equations: Gaussian Elimination and Cramer’s Rule

**Recommended Reading:**


**Required Reading:**


(b) Convexity:

- Convex Set, Convex Hull, Extreme Points and Convex Cone
- Carathedory’s Theorem
- Convex, Concave, Quasiconvex and Quasiconcave Functions
- Separating Hyperplane Theorems

Recommended Reading:


Required Reading:


III. Calculus: (Lectures 10-12)

Differentiation and Integration:
- The Derivative of a Real Function
- Mean Value Theorems
- L'Hospital’s Rule and Taylor’s Theorem
- Integral of a Real Valued Function
- Integration and Differentiation: The Fundamental Theorem of Calculus
- Integration by Parts and Leibniz Integral Rule
- The Inverse Function Theorem and The Implicit Function Theorem

Required Readings:


IV. Optimization (Lectures 13-17)

Static Optimization:
- Linear Programming, Duality Theorems and Simplex Method
- Weierstrass Theorem: Existence of a Maximizer
- Unconstrained Optimization: Fermat’s Theorem, First and Second Order Conditions
- Constrained Optimization: Constraint Set, Lagrangean, KT-conditions
- Convexity and Optimization: Necessity and Sufficiency
- Saddle Point Theorem, The Envelope Theorem and the Theorem of the Maximum

Recommended Reading:


Required Reading:


V. Difference and Differential Equations (Lectures 18-20)

Difference and Differential Equations:
- Difference Equations
- Cobweb Diagram
- First and Second Order Linear Differential Equations
- Homogenous and Nonhomogenous Differential Equations
- Phase Diagram
- System of Differential Equations
- Existence and Stability of Rest Points

Recommended Reading:


Required Reading: