Mathematical Methods for Agricultural and Resource Economists
Syllabus

SB refers to Mathematics for Economists, by Carl Simon and Larry Blume (SB). MWG refers to Mathematical Appendix to Microeconomic Theory, by Mas-Colell, Whinston and Green (MWG). The texts are only peripherally related to the course material. The chapter guides are only approximate.

(1) **Analysis**
   - (a) Sequences
   - (b) Distance/Metrics
   - (c) Convergence of Sequences
   - (d) Least Upper bounds and Greatest Lower Bounds
   - (e) Cauchy Sequences
   - (f) Topology of $\mathbb{R}^n$
   - (g) Continuous Functions

(2) **Linear Algebra**
   - (a) Vectors as arrows.
   - (b) Vector operations
   - (c) Projections
   - (d) Proof of the cosine formula theorem
   - (e) Linear Combinations, Linear Independence, Linear Dependence and Cones.
   - (f) Vector Spaces
   - (g) Spanning, Dimension, Basis
   - (h) Matrices and Rank
   - (i) Linear Functions
   - (j) The “graph” of a linear function from $\mathbb{R}^2$ to $\mathbb{R}^2$
   - (k) Computational details
   - (l) Determinants, Rank and volume
   - (m) Solving linear equation systems and Cramer’s Rule
   - (n) Eigenvalues, eigenvectors and difference Equations

(3) **Graphical Overview of Optimization Theory**
   - (a) Unconstrained optimization — one variable
   - (b) Convex sets, Concave and Convex Functions
   - (c) Strictly Concave and Convex Functions and Strict (Locally Unique) Maxima
   - (d) Constrained optimization — one variable
   - (e) Unconstrained optimization — several variables
   - (f) Level Sets, upper and lower contour sets and gradient vectors
   - (g) Quasiconcavity and quasiconvexity; strict quasiconcavity
   - (h) Constrained optimization — several variables
(4) Univariate and Multivariate Differentiation
   (a) The fundamental notion: linear approximations to nonlinear functions.
   (b) The Differential in Univariate Calculus
   (c) Partial Derivative, Cross Partial and Total Derivatives
   (d) The differential in Multivariate Calculus: real-valued functions
   (e) The differential in Multivariate Calculus: vector-valued functions
   (f) Taylor’s Theorem
   (g) Application of Taylor’s theorem: second order conditions for an unconstrained maximum

(5) Characteristics of functions
   (a) Terminology Review
   (b) Surjective, Injective and Bijective functions
   (c) Homotheticity
   (d) Homogeneity and Euler’s theorem
   (e) Monotonic functions
   (f) Concave and quasi-concave functions; Definiteness, Hessians
   (g) Second Order conditions, Definiteness and Semidefiniteness

(6) Constrained Optimization
   (a) Existence and Uniqueness
   (b) Necessary and sufficient conditions for a solution to an NPP
   (c) Demonstration of why the KT conditions are really necessary
   (d) Interpretation of the Lagrange Multiplier
   (e) KT conditions and the Lagrangian approach
   (f) Computing a solution to a NPP: a worked example
   (g) Second Order conditions for a Constrained Maximum

(7) Foundations of Comparative Statics
   (a) The envelope theorem (unconstrained version).
   (b) The envelope theorem (constrained version).
   (c) Implicit function theorem
   (d) Genericity and Transversality
   (e) The implicit function theorem and comparative statics.
   (f) The inverse function theorem