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Preparatory Math Course
Preliminary Outline

Sets and Proofs

- Logical operators, De Morgan's laws
- Methods of proof: Induction, Deduction, Contradiction
- Functions, Mappings: surjective, injective, bijective

Metrics, Sequences and Limits

- Euclidean space: field definition, the Real number system, Cartesian product, Euclidean distance
- Metrics
- Vector norms
- Open and closed sets, open and closed spheres
- Sequences: convergent sequences, sequences in $\mathbb{R}$, subsequences in $\mathbb{R}$, Cauchy sequences
- Contraction mapping theorem
- Limits of functions
- Continuity of functions, extreme and intermediate value theorems, monotonic functions
- Infinite limits
- Mathematical paradoxes

Matrix Algebra

- Basic matrix operations: summation, multiplication, transpose, trace, determinant, rank, inverse
- Eigenvalues and eigenvectors
- Matrix decompositions: eigendecomposition, Jordan decomposition, Cholesky decomposition

- Orthogonal matrices
- Definite matrices
- Matrix operators: Kronecker product, matrix vectorization

Calculus

- Differentiation: definition, implicit differentiation, Taylor series, power series
- Maximization
- Integration: indefinite integral, definite integral
- Differential equations
- Multivariate differentiation: partial derivatives, gradient, Hessian, Jacobian
- Matrix differentiation: rules, directional derivatives
- Multiple integrals
- Logarithms
- Complex numbers, De Moivre's Theorem
- Homogenous functions
- Implicit function theorem
- Inverse function theorem
- Fixed point theorems

Probability and Statistics

- Probability: definition, axioms, properties, conditional probability
- Independent events
- Random variables
- Probability densities: continuous and discrete
- Cumulative densities
- Joint, marginal and conditional distributions
- Change of variable technique
- Expectation, conditional expectation, law of iterated expectations

- Population and sample moments
- Common distributions
- Frequentist estimation, estimator properties, convergence results

Concavity and Convexity

- Convex sets, convex hull
- Hyperplane
- Hyperplanes, separating hyperplane theorem
- Concave functions, convex functions
- Concavity, quasiconcavity
- Correspondence, hemicontinuity

Other Potential Topics

- Linear programming
- Dynamic programming
- Kuhn-Tucker conditions
- Scalar field gradients

Notes

To prepare you can make use of the following references: Chiang & Wainwright (2005), De la Fuente (2000), Hamilton (1994), Judge, Hill, Griffiths, Lutkepohl & Lee (1988), Lucas, Stokey & Prescott (1989), Mas-Colell, Whinston, Green & others (1995), Simon & Blume (1994). You can also find all of the topics online on Wikipedia, Wolfram Mathworld or other sites.

References

Chiang, A. & Wainwright, K. (2005). *Fundamental Methods of Mathematical Economics*. McGraw-Hill, New York.

De la Fuente, A. (2000). *Mathematical Methods and Models for Economists*. Cambridge University Press.

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Lucas, R., Stokey, N., & Prescott, E. (1989). *Recursive Methods in Economic Dynamics (Ch. 3)*.

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