THE UNIVERSITY OF THE WEST INDIES

MONA CAMPUS
Department of Economics
Kingston 7
Jamaica, W.I.

ECON9007: Mathematics for Economists

Year: Semester I, 2019

Eligibility Requirements: Acceptance into the PhD Economics programme

Pre-Requisite: Calculus (ECON2016), Matrix Algebra (ECON2015)

Anti-Requisites: None

Lecturer: Nadine McCloud

Course Description

Mathematics for Economists is a critical course in mathematics for incoming PhD students in Economics. Mathematics for Economists aims to:

1. Provide the students with the rudimentary mathematical tools needed to understand the other first-year courses, navigate the field of economics at higher levels of the PhD and equip them with the mathematical skills required to digest quantitatively-intensive economic journal articles.

2. Give the students an understanding of the concepts beneath, and the applicability and inapplicability of, these tools.

3. Familiarise the students with different theorem-proof methods of analyses.

4. Teach students how to think and write mathematically.

Without mastery of these techniques, it will be difficult for the students to digest the professional literature and to contribute to it.

Learning Outcomes

Upon successful completion of the course, the student should be able to:

- Define and explain concepts of a relation, a function, an open set, a closed set, a compact set, a convex set and to graph simple functions such as linear functions, quadratic functions, polynomial function, rational functions, exponential functions, and logarithmic functions, and to draw level curves for some commonly used functions in economics.
- Identify some basic properties of a function such as monotonicity, continuity, and differentiability, concavity, convexity, quasi-concavity, quasi-convexity, homogeneity, and homotheticity.
- Perform basic matrix operations such as matrix addition and subtraction, matrix multiplication and to compute determinant, inverse, eigenvalues an eigenvectors of matrices.
- Analyse solutions to systems of linear equations and to solve systems of linear equations using the matrix inverse method and Cramer's rule.
- Prove certain classical and recent results of matrix analysis
- Do differentiations for multi-variable functions using various differentiation rules (sum, difference, product, quotient, and chain rule).
- Do comparative statics using implicit function theorems
- Identify and characterise the extreme values of multi-variable functions
- Solve optimisation problems with inequality constraints through the Kuhn-Tucker method.
- Solve simple differential equations and systems of differential equations and to analyse the stability of equilibrium using phase diagrams
- Formulate economic questions as dynamic programming problems
- Use different theorem-proof methods of analyses – induction, direct, contrapositive and converse

Modes of Delivery

Face-to-face. Three hours of lectures per week. Some of these lecture hours are for problem-solving sessions.

Assessment

- Problem Sets (20%)
- One mid-semester exam (40%)
- Final exam (40%)

Course Content

A. Definition of Real Numbers (week 1)
   - Ordered Fields
   - Principle of Mathematical Induction
   - Completeness axiom
   - Extended Reals

B. Real Analysis (weeks 2 and 3)
   - Metric spaces
   - Topology
   - Closures, boundaries and Interior points
   - Continuity
   - Real Sequences, Bolzano-Weierstrass theorem
   - Cauchy Sequences and Completeness
   - Separability and connectedness
   - Compactness
   - Applications: Weierstrass theorem, Theorem of the maximum, Banach fixed point theorem, utility maximisation

C. Linear Algebra (weeks 3 and 4)
   - Definition of linear space and subspaces
   - Linear dependence
   - Span, basis, and dimensions
   - Inner products, norms, and the Cauchy-Schwartz inequality
   - Affinity
   - Linear operators and the Fundamental theorem of calculus
   - Subspaces attached to a matrix

D. Convex Analysis (weeks 5 and 6)
   - Convex sets
   - Caratheodory's theorem
   - Separation Theorems
   - Theorems of the alternative - Farkas Lemma

E. Calculus (weeks 7 and 8)
   - Definition of a derivative, differentiable function, etc
   - Taylor Expansions
   - Implicit function theorem

F. Static Optimization (weeks 9 and 10)
    - Unconstrained optimisation – First- and second-order conditions
    - Proof of Kuhn Tucker conditions with equality constraints
    - Proof of Kuhn Tucker conditions with inequality constraints

G. Dynamic Programming (weeks 11 to 13)
    - Contraction mapping
    - Blackwell's sufficient conditions
    - Statement of the problem
    - Finite dynamic programming
    - Principle of Optimality and the Bellman equation
    - Benveniste and Scheinkman
    - Transversality conditions
    - Hamiltonians

Reading Material

Prescribed

- Simon, C. and L. Blume, Mathematics for Economists (W.W. Norton, London, 1994

- Ok, Efe A., Real Analysis with Economic Applications (Princeton University Press, 2007)

- Galor, Oded, Discrete Dynamical Systems (Springer, 2010)

- Horn, R. A. and Johnson, C. R., Matrix Analysis (Cambridge University Press, 2nd edition, 2012)

Recommended

- Dixit, Optimization in Economic Theory, (Oxford University Press, 1990, 2nd edition, 1992).

- A. Chiang, Fundamental Methods of Mathematical Economics (McGraw-Hill, 1984).

- A. Chiang, Elements of Dynamic Optimization (Waveland Press, 2000).

- M. Carter, Foundations of Mathematical Economics (MIT Press, 2001).

- Rudin, W., Principles of Mathematical Analysis (McGraw-Hill, 1976)

- Lucas, R., N. Stokey with E. Prescott, Recursive Methods in Economic Dynamics, (Harvard University Press, 1989)

- Rudin, W., Principles of Mathematical Analysis (McGraw-Hill, 1976)