Mathematics

September 9 to December 18, 2020

Juan Pablo Rincón-Zapatero

Office number: 15.2.41
Telephone: + 34 91 624 8666
Office hours: M, 15:00–16:00 and W, 16:00–17:00
E-mail: jrincon@eco.uc3m.es

Lectures: M and W, 9:00–10:30 Rm 18.1.07
Practical Class: F, 9:00–10:30 Rm 18.1.07

Timetable

Week 1. Set Theory and the Real Line. Topology in Euclidean spaces

- Session 1: Ordered Sets. Finite, Countable and Uncountable Sets. The Real Field.
- Session 2: Euclidean Spaces. Open, closed and compact sets. Completeness.
- Session 3: (Practical): Resolution of problems about Set Theory, the Real Line and topology in Euclidean spaces.

Week 2. Numerical Sequences and Series

- Session 1: Convergent Sequences. Subsequences. Cauchy Sequences.
- Session 2: Convergent and Divergent Series. Series of Nonnegative Terms. The Root and Ratio Test. Power Series. Absolute Convergence.
- Session 3: (Practical): Review of Homework 1. Resolution of problems on numerical Sequences and Series.

Week 3. Continuity

- Session 1: Limits of Functions. Continuous Functions. Theorems on Continuous Functions.
- Session 2: Monotonic Functions. Convex and Concave Functions.
- Session 3: (Practical): Resolution of problems on continuity of functions.

Week 4. Differentiation

- Session 1: The Derivative of a Real Function. Partial and Directional Derivatives. Differentiability.
- Session 2: Inverse and Implicit Function Theorems. Higher Order Derivatives. Taylor's Theorem.
- Session 3: (Practical): Review of Homework 2. Resolution of problems on differentiation of functions.

Week 5. Integration (I)

- Session 1: Definition and Properties of the Riemann Integral. Fundamental Theorem of Integral Calculus and Barrow's Rule. Iterated integrals.
- Session 2: Improper Integrals. Limitations of the Rieman integral.
- Session 3: (Practical): Resolution of problems on Rieman and improper integrals.

Week 6. Integration (II)

- Session 1: Introduction to measure theory.
- Session 2: Lebesgue integral.
- Session 3: (Practical): Review of Homework 3. Resolution of problems on measure and Lebesgue integral.

Week 7. Integration (III)

- Session 1: Theorems of the Monotone Convergence, Fatou and Lebesgue Dominated Convergence. Theorem of Fubini.
- Session 2: Random variables, expectation and conditional expectation.
- Session 3: (Practical): Resolution of problems on convergence and Fubini theorems.

Week 8. MIDTERM EXAM

Week 9. Sequences and Series of Functions

- Session 1: Punctual and Uniform Convergence. Equicontinuity.
- Session 2: Uniform Convergence and Continuity, Differentiation and Integration.
- Session 3: (Practical): Review of Homework 4. Resolution of problems on Sequences and Series of Functions.

Week 10. Metric Spaces

- Session 1: Distance. Open, Closed and Compact Sets.
- Session 2: Banach and Complete Metric Spaces. Function Spaces.
- Session 3: (Practical): Resolution of problems on metric spaces.

Week 11. Fixed Point Theorems of Functions

- Session 1: Theorems of Brower and Schauder-Tychonoff
- Session 2: Contractions mappings. Banach Theorem.
- Session 3: (Practical): Review of Homework 5. Resolution of problems on Fixed Points.

Week 12. Correspondences

- Session 1: Definition and Properties of Correspondences. Lower and Upper Hemi-Continuous Correspondences.
- Session 2: Alternative characterizations of Lower and Upper Hemi-Continuity.
- Session 3: (Practical): Resolution of problems on correspondences.

Week 13. Parametric Optimization (I)

- Session 1: Review of optimization techniques.
- Session 2: Maximum Theorem of Berge.
- Session 3: (Practical): Review of Homework 6. Resolution of problems on parametric optimization.

Week 14. Parametric Optimization (II)

- Session 1: The Concave and the Monotone Maximum Theorem.
- Session 2: Supermodularity. Theorem of Topkins.
- Session 3: (Practical): Resolution of problems on the Maximum Theorem.

Week 15. FINAL EXAM