
MATHEMATICS

September 1st, 2022

Outline

The goal of this course is to help students understand and use the mathematics required for studying economics at the graduate level. As a way of demonstrating the importance of mathematics in economics, the mathematical concepts studied will be illustrated with applications in economics.

Topics

Single-variable calculus

- 1 Functions. Continuity, limits, derivatives and differentials. Composite functions and the chain rule.
- 2 Single variable optimization. Integrals.

Linear algebra

- 3 Vectors and matrices. Matrix operations. Trace, determinant, rank and the inverse of a matrix. Main results on linear systems.
- 4 Eigenvalues, eigenvectors and diagonalization. Quadratic forms. Vector spaces.

Analysis in \mathbb{R}^n

- 5 Some topologic concepts. Metric spaces. Open and closed sets, interior and closure.
- 6 Sequences. Convergence. Compactness. Cauchy sequences.
- 7 Limits and continuity. Functions. Limit of a function. Continuity. Weierstrass' theorem.

Multivariable calculus

- 8 Partial and directional derivatives. Differentiability. The gradient.
- 9 Level sets. Chain rule. Higher-order derivatives. Taylor formula. Integration.
- 10 Inverse function theorem. Implicit function theorem. An application: IS-LM model.
- 11 Convex sets. Separating hyperplanes. Convex and concave functions. Quasi-concave and quasi-convex functions.

Static optimization

- 12 Unconstrained optimization. Some definitions. First-order conditions. Second-order conditions. Global maximum and minimum. An application: OLS estimation.
- 13 Optimization with equality constraints. Lagrange method. Necessary conditions. Sufficient conditions. Interpretation.
- 14 Optimization with inequality constraints. Geometric deduction. Kuhn-Tucker (1951)'s conditions. Formulation in terms of the Lagrangian. The convex case.

Difference and differential equations

- 15 Introduction to difference equations. Examples. Some useful methods.
- 16 Introduction to differential equations. Examples. Some useful methods.
- 17 Linear difference equations of order n . Difference equations of order n . The linear case. The constant coefficients case. Particular solutions.
- 18 Linear differential equations of order n . Differential equations of order n . The constant coefficients case. Particular solutions.

Dynamic systems

- 19 1^{st} -order systems of difference equations. The linear case. From a linear difference equation of order n to a 1^{st} -order system. Homogeneous systems. Full systems.
- 20 1^{st} -order systems of differential equations. From a linear differential equation of order n to a 1^{st} -order system. Homogeneous systems. The time-invariant case. Full systems.

Grading

The Monday after the end of the course there is a final exam. In addition, there will be a problem set that will be graded. The final grade of the course will be a weighted average of the final exam (80%), homework (15%) and class participation (5%).

Basic references

Simon, C.P. and Blume, L. (2010) *Mathematics for Economists*. W.W. Norton, New York.

Sydsaeter, K. and Hammond, P. (2006). *Essential Mathematics for Economic Analysis*. Second Edition. Prentice Hall, Harlow, England.

Sydsaeter, K. and Hammond, P. (2005). *Further Mathematics for Economic Analysis*. Prentice Hall, Harlow, England.

Additional references

Apostol, T.M. (1974). *Mathematical Analysis*. Second Edition. Addison-Wesley, Reading, Massachusetts.

Binmore, K.G. (1983). *Calculus*. Cambridge University Press, Cambridge.

Burger, E.B. and Starbird, M. (2005). *The Heart of Mathematics. An invitation to effective thinking*. Second Edition. Key College Publishing. Emeryville, California.

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

Gilbert, L. and Gilbert, J. (1995). *College Algebra with Trigonometry*. McGraw-Hill, New York.

Haeussler, E.F. and Paul, R.S. (1996). *Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences*. Eighth Edition. Prentice Hall, Upper Saddle River, New Jersey.

Jacques, I. (1999). *Mathematics for Economics and Business*. Third Edition. Prentice Hall, Harlow, England.

Klein, M.W. (1988). *Mathematical Methods for Economics*. Addison-Wesley, Reading, Massachusetts.

Mas-Colell, A., Whinston, M.D., and Green, J.R. (1995). *Microeconomic Theory*. Oxford University Press.

Novshek, W. (1993). *Mathematics for Economists*. Academia Press, San Diego.

Woolridge, J. (2006). *Introductory Econometrics: A Modern Approach*. South-Western College Publishing. Third Edition.