B.E. International Program

Faculty of Economics, Thammasat University

Course Syllabus

EE421 Mathematical Economics I

Semester 2/2025 (January 5 – May 2, 2026)

Number of credits: 3 credits (3-0-6)

Lecture Time: Friday 9.00 – 12.00 hours

Lecture Venue: Room 204, Faculty of Economics

Instructor: Dr. Thanet Makjamroen

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Office hours: by appointment

Course Description

The application of matrices, Jacobian determinants, derivatives, partial derivatives and optimization, with and without constraints, to explain theories in Microeconomics and Macroeconomics, such as the theory of consumer behavior, The theory of production, equilibrium in goods and factor markets, equilibrium of national income in product and money markets, international trade, comparative static equilibrium analysis, the input-output model, determination of maximum-minimum point and duality of linear programming.

Course Objectives:

This course aims to provide the foundation of optimization as applied to the theory of Economics. The course covers the optimization of differentiable functions of single and several variables, both with and without constraints. Comparative Static analysis will be discussed with the use of Implicit Function Theorem and Envelope Theorem with matrix differentiation and algebra.

Prerequisites: MA217 (or MA212) and have completed or currently taking EE311

Text: Jeffrey Baldani, et. al., *Mathematical Economics*, 2nd edition, Dryden 2004.

Lecture Notes: Thanet Makjamroen, *Lecture Notes for EE421 Mathematical Economics I*.

References:

Gale [1960], *The Theory of Linear Economic Models*, McGraw-Hill.
Jehle [1991], *Advanced Microeconomics Theory*, Prentice-Hall.
Sundaram [1996], *A First Course in Optimization Theory*, Cambridge University Press.
Simon and Blume [1994], *Mathematics for Economics*, Norton.
Sydsaeter and Hammond [1995], *Mathematics for Economic Analysis*, Prentice-Hall.

Evaluation:

Midterm Exam	45%	(February 27, 2026; 9.00 – 11.30 hrs.)
Final Exam	55%	(May 19, 2026; 09.00 – 12.00 hrs.)

Topics:

Chapter 1 Introduction
- 1.1 Mathematical Economic Model
- 1.2 Use of Economic Model
- 1.3 An Example of Mathematical Models

Chapter 2 Calculus of Single Variable
- 2.1 Derivative
- 2.2 Examples of Derivatives in Economics
- 2.3 Derivatives and Increasing Functions
- 2.4 Second- and Higher-Order Derivatives
- 2.5 Optimization: Single Variable
  - 2.5.1 Necessary Conditions
  - 2.5.2 Sufficient Conditions
- 2.6 Concave and Convex Functions
- 2.7 Differentials

Chapter 3 Calculus of Single Variable: Applications
- 3.1 Labor Union
- 3.2 Profit Maximization in Perfect Competition
- 3.3 Profit Maximization of a Monopoly
- 3.4 Taxation on Monopoly
- 3.5 Profit Maximization of Duopoly (Cournot Model)
- 3.6 Balanced-Budget Multiplier

Chapter 4 Multivariate Calculus
- 4.1 Partial Derivatives
- 4.2 Second-Order Partial Derivatives and Cross Partial Derivatives

4.3 Total Differentials
4.4 Conventions of Matrix Notations for Derivatives of Functions of Several Variables
4.5 Chain Rules of Composite Functions of Several Variables
4.6 Directional Derivatives
    4.6.1 First-order Directional Derivatives
    4.6.2 Directional Derivatives and Optimization
    4.6.3 Second-order Directional Derivatives
4.7 Mean-Value Theorem
4.8 Taylor's Polynomials and Taylor's Approximation in $\boldsymbol{R}^n$
4.9 Implicit Functions and Implicit Function Theorem
4.10 Level Sets, Tangents and Gradients
4.11 Homogeneity

Chapter 5 Multivariate Calculus: Applications

5.1 Balanced-Budget Multipliers in Closed Economy
    5.1.1 Simple Keynesian Model
    5.1.2 IS-LM Model
    5.1.3 Aggregate Demand-Aggregate Supply Model
5.2 Monetary Policy Effectiveness
    5.2.1 IS-LM Model
    5.2.2 Mundell-Fleming Model with Flexible Exchange Rate
5.3 Tax Incidence in Supply-Demand Model

Chapter 6 Multivariable Optimization without Constraints

6.1 Definitions of Extreme Points
6.2 2-Variable Optimization
6.3 First-Order Necessary Condition
6.4 Second-Order Necessary Condition
6.5 Sufficient Conditions
6.6 Multivariable Optimization without Constraints
6.7 First-Order Necessary Condition
6.8 Second-Order Necessary Condition
6.9 Sufficient Conditions
6.10 Test of Definiteness of the Hessian
6.11 Concavity, Convexity and Optimization
6.12 Comparative Statics Analysis

Chapter 7 Multivariable Unconstrainted Optimization: Applications

7.1 Competitive Firm Input Choices: Cobb-Douglas Technology
7.2 Competitive Firm Input Choices: General Production Technology
7.3 Multiplant Firm
7.4 Multi-Market Monopoly
7.5 Statistical Estimation: Linear Regression

Chapter 8 Constrained Optimization: Equality

8.1 The Lagrangian Method
8.2 Graphical Interpretation
8.3 Optimization with *k* Equality Constraints