

## Course Outline

### EE421 Mathematical Economics I

Semester 2/2020 (January 20 - May 19, 2021)

<b>Enrollment Key</b>	1678
<b>Number of credits:</b>	3 credits
<b>Lecture Time:</b>	Tuesdays and Thursdays, 12.30 – 14.00 hours
<b>Lecture Venue:</b>	Online learning platform: ZOOM
<b>Instructor:</b>	Dr. Thanet Makjamroen Office: Room No. 521 Fifth Floor, Faculty of Economics Email: thanet@econ.tu.ac.th 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*, 2<sup>nd</sup> edition, Dryden 2004.

**Lecture Notes:** Thanet Makjamroen, *Lecture Notes for EE421 Mathematical Economics I*, May 2008.

**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    40%    **(March 11, 2021; 12.00 – 14.00 hrs.)**

Final Exam        60%    **(May 25, 2021; 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  $\mathbf{R}^n$

4.9 Implicit Functions and Implicit Function Theorem

4.10 LevelSets, 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 Unconstrained 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 Monopology
- 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
- 8.4 Second-order Sufficient Conditions
  - 8.4.1 Bordered Hessian for Single Equality Constraint
  - 8.4.2 Bordered Hessian for  $k$  Equality Constraints
  - 8.4.3 Test of Bordered Matrix
- 8.5 Comparative Static Analysis: Sensitivity Analysis

**Chapter 9      Equality Constrained Optimization: Applications**

- 9.1 Cost Minimization and Conditional Input Demand
  - 9.1.1 Sufficient Conditions
  - 9.1.2 comparative Static Analysis
- 9.2 Utility Maximization: Log Utility Function
- 9.3 Utility Maximization Subject to Budget and Time Constraints
  - 9.3.1 Sufficient Conditions
  - 9.3.2 Sensitivity analysis
- 9.4 Intertemporal Consumption
  - 9.4.1 2-Period Case
  - 9.4.2  $n$ -Period Case

**Chapter 10     Inequality Constraints Optimization**

- 10.1 First-Order Sufficient Conditions: One Inequality Constraint
- 10.2 First-Order Sufficient Conditions: Several Inequality Constraints
- 10.3 First-Order Sufficient Conditions: Mixed Constraints

10.4 First-Order Sufficient Conditions: Minimization under Mixed Constraints

10.5 Second-Order Sufficient Conditions: Mixed Constraints

10.6 Second-Order Necessary Conditions

10.7 Comparative Static analysis: Sensitivity Analysis

10.8 Kuhn-Tucker Formulation

**Chapter 11 Inequality Constrained Optimization: Applications**

11.1 Utility Maximization with Two Goods

11.2 Two Goods Diet Problem: Linear Programming and its Duality

11.3 Sales Maximization

11.4 Intertemporal Consumption with Liquidity Constraint

**Chapter 12 Sensitivity Analysis and Envelope Theorems**

12.1 The Meaning of the Multipliers

12.2 The Meaning of Lagrange Multiplier: One Equality Constraint Case

12.3 The Meaning of Lagrange Multiplier: Several Equality Constraint Case

12.4 The Meaning of Lagrange Multiplier: Inequality Constraint Case

12.5 Envelope Theorems

12.6 Envelope theorem: Unconstrained Case

12.7 Envelope Theorem: Equality Constraints Case

12.8 Applications: Shephard's Lemma, Roy's Identity and Demand Function

12.9 Envelope Theorem: Inequality Constraints Case



## Expected Learning Outcomes:

### 1. Morality and Ethics

Applicability	Learning Goals
●	1.1 Students demonstrate integrity.
○	1.2 Students prioritize social and public benefits over personal ones.
●	1.3 Students are punctual and comply with the code of conduct of the institution and society at large.
○	1.4 Students are responsible and accountable to society, the nation, and the subject of economics.
○	1.5 Students realize the cultural and environmental value of the sustainable society.

### 2. Knowledge

Applicability	Learning Goals
●	2.1 Students know and understand modern economics principles and theories, and are up to date with new developments.
●	2.2 Students know and understand Thai and global economic structure, and the importance of major international economic events.
●	2.3 Students know and understand instruments of economic analysis.
●	2.4 Students know and understand applied fields in economics, including monetary, public, international, business, natural resource and environmental, industrial, agricultural, cooperative, political, developmental, and entrepreneurial economics as well as agribusiness.
○	2.5 Students are informed about related fields including sociology, business administration, education, law policy, and science.

### 3. Intellectual Development

Applicability	Learning Goals
●	3.1 Students have developed individual critical thinking.
●	3.2 Students are sufficiently trained in research skills.
●	3.3 Students demonstrate an ability to analyze and synthesize data, as well as appropriately integrate economics concepts to understand causes of current economic problems in Thailand. Based on analysis and synthesis, students demonstrate an ability to propose policy guidelines to resolve problems.

#### 4. Interpersonal Skills and Responsibilities

Applicability	Learning Goals
<input checked="" type="radio"/>	4.1 Students are responsible for assigned tasks and work in groups effectively.
<input checked="" type="radio"/>	4.2 Students have problem-solving skills.
<input type="radio"/>	4.3 Students show leadership skills and team spirit.
<input checked="" type="radio"/>	4.4 Students are always improving themselves.
<input type="radio"/>	4.5 Students have good interpersonal skills, adapting and working under different conditions.

#### 5. Quantitative Analysis, Communication and Information Technology

Applicability	Learning Goals
<input checked="" type="radio"/>	5.1 Students select and apply appropriate statistical and mathematical methods for data processing, interpretation, conclusions, and recommendations to resolve problems.
<input type="radio"/>	5.2 Students communicate effectively and select appropriate presentation methods.
<input checked="" type="radio"/>	5.3 Students use information and communication technologies appropriately to gather data as well as process, interpret, and present results.

#### Remarks:

- ◆ **Mid-Term Examination:**      **Thursday, March 11, 2021, 12.00 - 14.00 hrs.**
- ◆ **Final Examination:**      **Tuesday, May 25, 2020, 09.00 – 12.00 hrs.**

## ACADEMIC CALENDAR & HOLIDAY

**Semester 2/2020**

**(January 20 – May 19, 2021)**

Activities	Time Period
Classes Begin	January 20, 2021
Add-drop period	January 25 - 29, 2021
Tuition payment period	January 30 - February 2, 2021
<i>Makha Bucha Day*</i>	<i>February 26, 2021</i>
Mid-term Examination Period	March 10 - 16, 2021
Withdrawal period with "W" on record	March 24 - May 6, 2021
<i>Chakri Memorial Day*</i>	<i>April 6, 2021</i>
<i>Songkran Day Festival*</i>	<i>April 12 - 18, 2021</i>
<i>Substitution for Visakha Bucha Day*</i>	<i>April 26, 2021</i>
<i>Coronation Day*</i>	<i>May 4, 2021</i>
<i>Royal Ploughing Ceremony Day*</i>	<i>May 11, 2021</i>
Last day of class	Wed, May 19, 2021
Final exam period	May 20 - June 5, 2021
<i>Visakha Bucha Day*</i>	<i>May 26, 2021</i>
<i>Queen Suthida's Birthday*</i>	<i>June 3, 2021</i>

*\* Public Holiday, No classes during this period*