THE UNIVERSITY OF HONG KONG
FACULTY OF BUSINESS AND ECONOMICS

School of Economics and Finance
ECON0703/ECON2285 – Mathematical Economics

GENERAL INFORMATION

Instructor: Dr. Jianrong Tian

Email: mailto:jt2016@hku.hk
Office: Room 1110, K K L Building
Phone: 2859 1050
Consultation time: Mon 15:35 – 16: 25
Semester: 1
Lecture time and venue: Mon 14:30-15:20 MWT4 & Thu 13:30-15:20 MWT5

Tutor: TBC
Pre-requisites: ECON1001/ECON1210 Introductory microeconomics
Co-requisites: NA
Mutually exclusive: NA

Course Website: NA
Other important details: NA

COURSE DESCRIPTION

Modern economic theory treated mathematically. Topics may include: applications of optimization to choice theory, monotone comparative statics, applications of differential and difference equations to stability of equilibria, applications of linear mathematics and fixed point theorems to Leontief and Arrow-Debreu models, and applications of optimal control theory and dynamic programming to certainty and stochastic dynamic optimization models.

COURSE OBJECTIVES

1. To understand the interconnection of economics and mathematics.

2. To understand optimization (both static and dynamic), the cornerstone of all modern economic theory.

3. To understand economic theory and application.

4. To extend analytic economic research in a methodological way.

COURSE LEARNING OUTCOMES

Course Learning Outcomes	Aligned Faculty Goals
CLO1 Ability to understand the interconnection of economics and mathematics.	Goal 1
CLO2 Competence in applying the concept and various theories of optimization.	Goal 1
CLO3 Skills in analyzing problems within the economic framework.	Goals 1, 4, 5
CLO4 Proficiencies in presenting and articulating ideas effectively on economic theories.	Goals 3, 5

COURSE TEACHING AND LEARNING ACTIVITIES

Course Teaching and Learning Activities	Expected contact hour	Study Load (% of study)
T&L1. Lectures: Instructor will give lectures on major concepts and issues.	36 hours	30%
T&L2. In-class and tutorial presentation and discussion: Students are expected to present their answers and engage in discussion during lectures and tutorial meetings. Most in-depth learning takes place when students actively engage in discussions and in sharing their ideas.	12 hours	10%
T&L3. Preparation of tutorial presentation	19 hours	15.8%
T&L4. Consultation: Both instructor and teaching assistant hold weekly consultation hours to answer students' questions.	3 hours	2.5%
T&L5. Self-study.	50 hours	41.7%
Total	120 hours	100%

Assessment Methods	Brief Description (Optional)	Weight	Aligned Course Learning Outcomes
A1. Tutorial Discussion		10%	CLO 1, 2 , 3 , 4
A2. Mid-term tests		30%	CLO 1, 2 , 3 , 4
A3. Final Exam		60%	CLO 1, 2 , 3 , 4
Total		100%	

STANDARDS FOR ASSESSMENT

Course Grade Descriptors

A+, A, A-	Strong evidence of superb ability to fulfill the intended learning outcomes of the course at all levels of learning: describe, apply, evaluate, and synthesis.
B+, B, B-	Strong evidence of ability to fulfill the intended learning outcomes of the course at all levels of learning: describe, apply, evaluate, and synthesis.
C+, C, C-	Evidence of adequate ability to fulfill the intended learning outcomes of the course at low levels of learning; such as describe and apply, but not at high levels of learning such as evaluate and synthesis.
D+, D	Evidence of basic familiarity with the subject.
F	Little evidence of basic familiarity with the subject.

Assessment Rubrics for Each Assessment (Please provide us the details in a separate file if the space here is not enough)

A1. Tutorial discussion

A+ A A-
Consistently well prepared for tutorials. Be enthusiastic to answer questions and participate in discussions. Attended almost all tutorials.

B+ B B-
Always prepared for tutorials. Be willing to answer questions and participate in discussions. Attended almost all tutorials.

C+ C C-
Not always prepared for tutorials. Be inactive to answer questions and participate in discussions. Attended some tutorials.

D+ D
Not prepared for tutorials. Be apathetic to answer questions and participate in discussion. Attended few tutorials

F
Rarely attended tutorials.

A2 and A3 Midterm and Final Exam
Midterm and final exam are consisted of calculation problems which are graded according to the marks assigned to each question.

COURSE CONTENT AND TENTATIVE TEACHING SCHEDULE

Chapter 0: Introduction and Development of Mathematical Economics
A. A philosophical viewpoint from calculus of variations to inter-connect nature, mathematics and economics
B. Historical Development of Mathematical Economics within General Economic Theory

Chapter I: Static Econ equilibrium models, Optimization in Mathematics & Economics and Linear Algebra (with economic applications as illustration)

A. Review of equilibrium models (S & D curves) and math preliminaries including differentiation for local optimization (compounding/discounting in Econ of Finance)
B. Integral Calculus: (consumer surplus and economic rent extraction)
C. Unconstrained optimization:
   - of single-independent-variable functions (productivity maximization, optimal timing in Econ of Finance)
   - for multivariate functions. (revenue maximization)
D. Economic Modeling (Keynesian Cross in Macroeconomics; S & D functions in a market in Microeconomics).
E. Linear (Matrix) Algebra and linear economic models
   Gaussian method (Keynesian Cross solution); determinants; Inverse matrix; Cramer's Rule (Leontief Input-Output Model)
F. Special determinants and matrices: Jacobian, Hessian
G. Unconstrained optimization of multivariate functions using Hessian
H. Constrained Optimization (Utility maximization subject to budget constraint)
I. Constrained optimization of multivariate functions with one equality/multi- constraint using bordered Hessian. (Derivation of Demand function).
J. Constrained optimization of univariate functions with 1 inequality constraint; and of multivariate function with m inequality constraints (cost minimization using Kuhn-Tucker conditions)
K. Nonlinear programming (NLP): concave programming with saddle point characterization. (Kuhn-Tucker-Uzawa Theorem)

Chapter II: Main Micro Econ Issues within Mathematical Economics Framework
A. Microeconomics:
   - Price Theory and Fundamental Theorems of Welfare Economics;
   - market vs. planned economy (transaction cost and property rights considerations);
   - Competitive Equilibrium C.E. and Pareto Optimality P.O.;
   - Rigorous proof of Adam Smith's Invisible Hand Theorem using vector maximum and NPL;
   - Welfare implications and Existence of C.E. (Brouwer's & Kakutani's FP Thm)
B. Market dynamics of adjustment processes and stability in Micro Econ. (not covered)

Chapter III: Intertemporal Models, Dynamic Economic Systems and Dynamic Optimization in Micro and Macro Econ.
A. Eigenvalues, Eigenvector and Markov matrix.
B. Discrete Dynamic Models - Difference equations
   -One-dimensional 1st order linear autonomous difference equation (Cobweb Market Adjustment Model in Micro Econ; Harrod Growth Model in Macro Econ; Derivation of FV formula in Finance); Recursive methods, 2nd order difference equations.

-Two-dimensional and m-dimensional first order linear difference equation (Discrete stochastic dynamic models; restaurant survival)
C. Continuous Dynamic Models - Differential equations. (Econ growth; Micro price elasticity of demand; Macro 2-sector income determination model.)
  - General formula and solution methods
  - 2nd order linear differential equation (market price adjustment model with inventory)
  - Bernoulli nonlinear differential equation; phase diagram (Simple Solow Growth Model, Solow Model with Cobb-Douglas
  - Aggregate production function solved by Bernoulli equation)
  - 2-dimensional differential equations (Micro econ stock market price trend and momentum model).
D. m-dimensional linear and nonlinear differential equation; continuous dynamic systems and stability. (Not covered)
E. Recapitulation of differential equations; Cauchy Peano Theorem
F. Dynamic optimization using Calculus of Variations; Euler's equation with proof; dynamic optimization subject to functional constraints (dynamic monopolistic pricing model; minimization of cost stream subject to dynamic constraints.)
G. Macro Growth Theory: dynamic optimization using Calculus of Variations & Pontryagin's Optimal Control Theory.
  - Brief Introduction
  - Simple Macro Growth models: growth models using power functions; Keynesian cross and Harrod growth models.
  - Neoclassical Solow growth models (AK growth models).
  - Macro optimal growth model using Calculus of Variations (phase diagram.)
  - Macro optimal growth model using Pontryagin's Optimal Control
H. Bellman's Dynamic Programming
  - Recursive multistage optimization (min budget expenditure for economic development)
  - Macro optimal discrete growth model using Bellman's dynamic programming with recursive methods.

Chapter IV: Economics of information, risks & uncertainty
A. Brief review of stochastic concepts and probability theory (stochastic optimization models in Econ of Finance; Insurance application: risks transference and Law of Large Numbers; CLT).
B. Von Neumann-Morgenstern (VNM) Expected Utility Theorem
C. Arrow-Debreu State-contingent commodities Model to extend the Fundamental Theorem of Welfare Econ to include risks. Complete market in Investment Theory. (not covered)
D. Insurance model. (Alternative statement of Arrow-Debreu State-of-nature model. Qualification: Asymmetrical information, moral hazard and adverse selection. Arrow-Pratt risk aversion measures and applications to insurance & Finance) (not covered)
E. Game theory: Complete information pure- & mixed-strategy static games; Nash Equilibrium (Duopolist sales strategies; 2-country international trade model). Existence theorems & Kakutani's Fixed Point Theorem. (management-union bargaining; oligopolists' output decision) (not covered)

REQUIRED/RECOMMENDED READINGS & ONLINE MATERIALS (e.g. journals, textbooks, website addresses etc.)

Lecture notes for the whole course will be posted on the Moodle at the beginning of the semester.

Reference textbooks:

Pemberton, M., Rau, N. Mathematics for Economists: An Introductory Textbook ,3ed (2011)
Hoy, M., Livernois, J., McKenna, C, Rees, R., Stengos, T., Mathematics for Economics 2ed. (2001)
Baldani, J., Bradfield, J., Turner, R.W.. Mathematical Economics, 2ed (2005)
Takayama, A., Mathematical Economics 2ed (1985)
Takayama, A., Analytical Methods in Economics (1993)
Sydsaeter, K., Hammond, P., Seierstad, A., Strom Arne. Further Mathematics for Economic Analysis, 2ed. Prentice Hall (2008)

MEANS/PROCESSES FOR STUDENT FEEDBACK ON COURSE

Conducting mid-term survey in additional to SETL around the end of the semester

COURSE POLICY (e.g. plagiarism, academic honesty, attendance, etc.)

Academic Conduct:
The University Regulations on academic dishonesty will be strictly enforced! Please check the University Statement on plagiarism on the web: http://www.hku.hk/plagiarism/. Academic dishonesty is behavior in which a deliberately fraudulent misrepresentation is employed in an attempt to gain undeserved intellectual credit, either for oneself or for another. It includes, but is not necessarily limited to, the following types of cases:

a. Plagiarism - The representation of someone else's ideas as if they are one's own. Where the arguments, data, designs, etc., of someone e being used in a paper, report, oral presentation, or similar academic project, this fact must be made explicitly clear by citing the appropriate references. The references must fully indicate the

extent to which any parts of the project are not one's own work. Paraphrasing of some else's ideas is still using someone else's ideas, and must be acknowledged.

b. Unauthorized Collaboration on Out-of-Class Projects - The representation of work as solely one's own when in fact it is the result of a j effort. Where a candidate for a degree or other award uses the work of another person or persons without due acknowledgement:

    1. The relevant Board of Examiners may impose a penalty in relation to the seriousness of the offence;

    2. The relevant Board of Examiners may report the candidate to the Senate, where there is *prima facie*

evidence of an intention to deceive where sanctions beyond those in (1) might be invoked.

Cheating on assignments or examinations is another act of academic dishonesty. If you are caught committing cheating, you will receive an "F" grade for the subject. Furthermore, the relevant Board of Examiners may impose a penalty in relation to the seriousness of the offence; or report the candidate to the Senate, where there is prima facie evidence of an intention to deceive.

Class Conduct: Students are required to attend all classes on time. If you miss a class, it is entirely your responsibility for what you have missed. The principle is based on mutual respect in the classroom. Mobile phone and/or alarming device must be switched off or muted. No eating is allowed during class periods. Discussions and questions are encouraged but student should first inform the instructor beforehand, but not chat with others in private.

ADDITIONAL COURSE INFORMATION (e.g. e-learning platforms & materials, penalty for late assignments, etc.)

Students are expected to be familiar with math at the level of University Mathematics 1.

Special Examinations
Student enquiries and applications for special examinations will be forwarded to the School Office to be handled in a formal and consistent manner. The School and the Chief Examiner may approach individual instructors for their recommendation if necessary. Controversial cases may be further discussed in the Internal Examiners' meeting and the Board of Examiners meeting.

In general, special examinations are not granted to students taking up summer internships. Students are advised to avoid starting their internships before the end of the examination period.

By default, special examinations would be approved:
(1) if incoming/outgoing exchange students have time clash with the next academic semesters in their home/host universities;
(2) due to compassionate reasons; and
(3) on extraordinary medical situation.

Plagiarism and Misconduct
Plagiarism and misconduct cases will be directed to the Chief Examiner and will be permanently recorded in the School for future reference.