Introductory Mathematical Economics

Syllabus (Revised August 3, 2018)

WISE, Xiamen University
Fall 2018

Course Information

Instructors

Professor: Ziyan Yang
Office: D313
Email: zyang@xmu.edu.cn
Office Hours: Monday 2:30 pm - 4:30 pm
Teaching Assistant: TBA
Email: TBA
Office: TBA
Office Hours: TBA

Location and Meeting Times

Lectures
Times: Tuesday **10:10 am - 11:50 am** & Thursday **7:10 pm - 8:50 pm**
Location: Nanqiang 2 **Room 406** &Nanqiang 2 **Room 404**
Discussion Sections
Time: TBA
Location: TBA

Required Texts and Reference

- Class notes and other materials will be handed out in class.
  The class notes are the main text for the course. The class notes will be handed out at the start of each class period. The slides I presented in class might be different from the class notes you received. Thus, note-taking is critically important and encouraged.
- A.K. Dixit, *Optimization in Economic Theory (2nd ed)*, Oxford, Oxford University Press, 1990.
- R.K. Sundaram, *A First Course in Optimization Theory*, Cambridge, Cambridge University Press, 1996.
- K. Sydsaeter, P. Hammond, and A. Strom, *Essential Mathematics for Economic Analysis*, Pearson Education Limited 2012
- K. Sydsaeter, P. Hammond, A. Seierstad and A. Strom, *Further Mathematics for Economic Analysis*, Harlow, Prentice Hall, 2005.
- William Thomson, *A Guide for the Young Economist (2nd ed.)*, Cambridge, MIT Press, 2011.

Prerequisites

Multivariable Calculus, Linear Algebra, basic principles of Microeconomics and Macroeconomics

Communication

- Course announcements (assignments, course or office hours cancellations, etc.) will be sent through a course email list.
- Communication between students and instructors/TA should mainly rely on in-class interactions and office hours.
- Emails could be used to set up a one-on-on meeting with me or the TA if our office hours conflict with your course schedule. Please use "Mathematical Economics - meeting request" as the subject line of your email.

Course Description and Goals

The purpose of the course is to provide students the mathematical tools for graduate study and research in economics. This course is designed to study the mathematical theory of optimization, which are most frequently used in economic models of the firm and consumer behavior. Topics include: necessary and sufficient conditions for constrained optimization, the role of convexity and concavity in optimization and comparative statics. If the time permits, I will slightly introduce the optimal control theory and dynamic programming.

By the end of the course, students are expected to 1) understand the theoretical part of most current journal articles in economics, 2) develop theoretical framework in mathematical format to interpret real-life phenomena, 3) be prepared for economics study in future graduate-level courses using a wide range of mathematical techniques, 4) develop a set of problem-solving and analytical skills to solve real-life problems.

Course Requirements and Grading

Course Requirements

Problem Sets:
There are several assignments handed out every one or two weeks. On each assignment, selected problems will be graded, but these will not be announced in advance. You are expected to answer all questions. An assignment is normally handed out in the first session (Monday) of a week. You should hand in your write-up of the answers before the start of the first session (Monday) of the next week. Late submission will result in a zero grade. You may work together on problem sets, but each student must hand in his or her own write-up. The write-up could be written by hand or by LaTeX.

- LaTeXis a document preparation system, using markup tagging conventions to define the general structure of a document, to stylize text throughout a document, and to add citations and cross-references (Wikipedia).

- LaTeX, a free-downloading software, has advantages in preparing documents containing mathematical equations and it is widely used in the profession of Economics.

- There are a great many open sources to learn LaTeX. The materials that I found most useful are the official website (`http://www.latex-project.org/help/documentation/`) and Wikibook LaTeX(`https://en.wikibooks.org/wiki/LaTeX`). I will also provide templates for frequently used document types.

In-Class Activities:
The in-class activities, randomly assigned, could be quizzes or group activities. Regular class participation is also counted as part of the in-class performance. Absences from in-class activities without acceptable reasons will result in a zero grade with absolutely no make-up opportunities under any circumstances. Acceptable reasons for missing an in-class activity include critical emergencies or illness. Students claiming excused absence must apply in writing and furnish documentary support for their assertion. Documentary support for excused absence should be given to the TA at least 48 hours in advance.

Team Research Project:
The research project is a team project, which is to develop a theoretical research on an economics question that is of interest to your team. This indicates that your research will typically involve the application of optimization methods to a problem in any fields of economics. An empirical analysis of a problem is not suited for this class. The research project has four components.

- Topics should be chosen by Oct 11. On a 1/2 single-spaced page, you should show what research topic you propose to study and why this topic can evolve into a publishable research paper (based on the literature review). It would be easier to address a specific problem or question rather than a broad and general topic. Either you would think about some real-life phenomenon, or you would start from an existing analysis with unrealistic or restrictive assumptions. Typing in *Microsoft Word* is fine, but LaTeXis highly recommended. All submissions should be in pdf format.

- A research proposal should be handed in by Nov 8. The proposal must have a minimum of 1.5 single-spaced pages of text (including a list of references). Besides introduction and literature review covered in the previous submission, this proposal should include 1) a theoretical model, which specifies a meaningful abstraction of real world relevance as an optimization problem, 2) model primitives, which clearly state an objective function, choice variables, constraints, and parameters, 3) assumptions, which ensure the optimization problem is well-behaved and characterize the properties of optimal solutions, 4) intuitive interpretation of assumptions. Typing in *Microsoft Word* is fine, but LaTeXis highly recommended. All submissions should be in pdf format.

- A final paper should be handed in by January 8&11. The final paper must have a minimum of 2.5 single-spaced pages of text (including a list of references). The final paper should reflect the revision of the previous two submissions and finish the research paper by analyzing the model and presenting intuition to explain the implications and insights from the analysis. Typing in *Microsoft Word* is fine, but LaTeXis highly recommended. All submissions should be in pdf format. Submissions in other formats will result in a zero grade.

- You should prepare a 15-minute presentation to the class on your research. **The slides must be prepared by LaTeX**. The slides are due before your presentation. The presentation should be similar to a conference presentation, focusing on introducing the problem, explaining its importance, developing a theoretical analysis, and providing economic insights. You should also actively participate in other students' presentations, giving comments or friendly criticizing.

As a guide to developing a research paper and presenting your research in public, you are expected to read William Thomson, *A Guide for the Young Economist: Writing and Speaking Effectively about Economics*:

- Ch. 1 for guidance on how to write a paper
- Ch. 2 for guidance on how to make an effective presentation

Exams:
Exams are not accumulative. The first two exams focus on static optimization and the last exam focuses on dynamic optimization. Acceptable reasons for missing an exam include critical emergencies or illness. Students claiming excused absence must apply in writing and furnish documentary support for their assertion. Documentary support for excused absence should be given to me at least 1 week in advance.

Key Dates and Grading

Date	Description
September 18	First day of classes
October 11	Research Topic Due
October 16&18	Pseudo First Mid-Term Exam (open book/discussion)
November 8	Research Proposal Due
November 22	Second Mid-Term Exam
January 6	Individual meeting for research project
January 8&11	Final Paper Due
January 15-20	Final Exam

Problem Sets		15%
In-Class Activities/Quizzes		15%
Exam 1		15%
Exam 2		20%
Exam 3		20%
Research Project	Module Assignments	15%

Course Policies

Attendance

Although attendance is not taken, you are expected to attend all classed and actively participate in class discussion. Absences from in-class activities or exams without acceptable reasons will result in a zero grade with absolutely no make-up opportunities under any circumstances.

Electronic Device Policy

Please turn off all electronic devices, including but not limited to laptops, ipads, tablets, phones, before the start of class.

Copyright Notice

Class lectures and other materials are copyrighted and they may not be reproduced for anything other than personal use without written permission from me. You may take notes and make copies of course materials for your own use. You may not and may not allow others to reproduce or distribute lecture notes and course materials publicly whether or not a fee is charged without my express written consent. Similarly, you own copyright in your original papers and exam essays. If I am interested in posting your answers or papers, I will ask for your written permission.

Software: Mathematica

Mathematica, a useful part of the economists toolkit, is popular in solving sophisticated optimization problems. *Mathematica* is powerful in solving both symbolic and numerical optimization problems. You are encouraged to use *Mathematica* to double-check your answers to your problem sets and support model building for your research project. Wofram provides many open-source tutorials (`http://reference.wolfram.com/language/guide/Optimization.html`).

Tentative Schedule & Reading List

Preliminary - to be covered by your own but will be in exams	
Sets, Sequences and Limits	Sundaram, Appendices A, B and C and Ch. 1.1-1.2. Sydsaeter, Appendix A, Ch. 13.1-13.2.
Basic Matrics	Sundaram, Ch. 1.3,1.5. Sydsaeter, Ch. 1.
Functions and Their Properties	Sundaram, Ch. 1.4-1.6.2. Sydsaeter,Chs. 2.1,2.6, 2.7 (1stedition), 13.3.
Week 1	
Unconstrained Optimization	Sundaram, Chs. 2,4. Sydsaeter, Ch. 3.1-3.2.
Existence of Solutions	Sundaram, Ch. 3.
Week 2	
Constrained Optimization: Equality Constraints	Dixit, pp. 1-28. Sundaram, Ch. 5. Sydsaeter, Ch. 3.3-3.4
Constrained Optimization: Inequality Constraints	Dixit, pp. 29-39. Sundaram, Ch. 6. Sydsaeter, Ch. 3.5-3.8.
Constraint Qualifications	Dixit, pp. 14,90. Sundaram, Ch. 5.2.2, 6.1.2. Sydsaeter, Ch. 3.6.
Week 3	
Shadow Prices	Dixit, Ch. 4. Sydsaeter, p. 121
Concavity and Convexity in Optimization	Dixit,Chs. 7 and Ch. 8, pp. 105-113. Sundaram,Chs. 7 and 8. Sydsaeter,Chs. 2.2-2.5, 3.9, 13.5-13.6.
Week 4	
Duality	Dixit, Ch. 6
Maximum Value Functions and the Envelope Theorem	Dixit, Ch. 5. Sydsaeter, pp. 109-111, 121-124, 134-136, 147-149
Week 5: Exam 1	
Week 6	
Monotone Comparative Statics: Implicit Function Methods	Sundaram, Ch. 1.6.3. Sydsaeter, Ch. 2.7, 2.8, 3.10.
Week 7	
Monotone Comparative Statics: Value Function or Duality Methods	Dixit, pp. 113-121.
Week 8	
Supermodularity or Complementarity Methods	Sundaram, Ch. 10.
Week 9	
Differential Equations	Sydsaeter,Chs. 5,6.
Week 10: Exam 2	
Week 11, 12	
Dynamic Optimization: The Maximum Principle (if possible)	Dixit, Ch. 10. Sydsaeter,Chs. 9,10.
Week 13, 14	
Dynamic Programming (if possible)	Dixit, Ch. 11. Sundaram,Chs. 11,12. Sydsaeter,Chs. 11,12.
Week 15	
Student Presentation	
Week 16: Exam 3	