ECON 3010: MATHEMATICAL METHODS OF ECONOMIC ANALYSIS

Fall 2022

Instructor:	Jetlir Duraj[a]
Lecture Times:	Tue, Thu 9:00am-10:15am
Instructor email:	JED169@pitt.edu
Lecture Location:	4940 WW Posvar Hall
Teaching Assistant:	Garrett Fiegenbaum
Recitation Time:	Fri 9:00am-10:15pm
Email:	glf17@pitt.edu
Recitation Location:	4900 WW Posvar Hall

[a]Call me Liri, read as *'Leary'*.

Course Page: The course website is available in Canvas: `https://canvas.pitt.edu/`. All course materials for the first part will be posted on Canvas.

Class Communications: All announcements will be posted on Canvas. It is the students' responsibility to monitor Canvas regularly.

Class Meetings:

1. I expect all classes will be recorded and the recordings made available on Canvas.
2. This class will meet in person in 4940 WW Posvar Hall unless Pitt Covid policy prescribes otherwise.

Office Hours: Liri: Tues. 4pm-5:30pm, location: WW Posvar Hall 4119.
Garrett: tba.
On office hours: Never ever be shy to ask questions! There are no 'dumb' questions (and correspondingly, there are also no 'smart' questions).
Please try to attend in groups to create positive spillover effects with your peers. If you understand an exercise, a theorem, an example, etc. better because you were in the office hour, and you know it was a 'mystery' to others as well, then you should share your deepened understanding with your other classmates.

Literature References: There is no single book which is a perfect fit for the material. You will be evaluated on how you understand and assimilate the lecture material on the slides and problem sets.

A collection of 'classical' books which cover quantitative methods for Econ PhDs follows. You can consult them whenever you find them helpful.

- Hoy, Livernois, McKenna, Rees and Stengos, *Mathematics for Economists*, MIT Press, 2011.
- Simon and Blume, *Mathematics for Economists*, W.W. Norton & Company, 1994.
- Chiang, Wainwright, *Fundamental Methods of Mathematical Economics*, McGraw-Hill Education, 4th ed., 2004.
- De La Fuente, *Mathematical Methods and Models for Economists*, Cambridge University Press, 2000.
- Ok, *Real Analysis with Economic Applications*, Princeton University Press, 2007
(this one requires some degree of mathematical maturity, but if you see you can handle it, it is highly recommended).

Objectives: This course is primarily designed for graduate students in the first term of the PhD track in Economics at Pitt. The aim of the course is to bring everyone on the same footing regarding knowledge in basic mathematical methods at the graduate level of economics. Every incoming class is typically diverse in terms of experience with math. Hence, you are encouraged to help each other understand and assimilate the material!

Ultimate practical goal is to help you develop skills and knowledge necessary to start reading advanced research papers in economics, understand the material of the other PhD classes, and ultimately write your own research papers.

Prerequisites: Math camp. Any other previous experience with quantitative methods and/or math will be helpful.

Topics:

1. Convex sets and separating hyperplane theorem
2. Static constrained optimization and the Karush-Kuhn-Tucker theorem
3. Complete metric spaces and contraction mapping Theorem
4. Dynamic programming with infinite and finite horizon
5. Affine and linear functions, Riesz representation Theorem, Mixture Theorem
6. Correspondences, Brouwer Fixed Point Theorem, Michael Selection Theorem, Kakutani Fixed Point Theorem
7. Dynamical Systems
8. Introduction to measure theory.

Very important: 1) Have a look at the slides on your own before every lecture! The class is supposed to be challenging by design, so plan to prepare before and after each lecture on the material of the respective lecture.
2) Learn the proofs! If you are relatively new to math and proofs, learning how a proof works will help you write your own and will deepen considerably your understanding of the material. Moreover, it will help you develop 'muscles' to cope with other quantitative material during your studies, no matter the subfield of economics. I will sample a couple of proofs from lecture and ask about them in the exams. I will always tell you beforehand the *population* of proofs from which I will sample.

Aside: How to learn a proof that was presented to you, if relatively new to math. First, you spend some time understanding the *mechanics* of a proof, i.e. just formally being able to *verify* that the proof arguments are logically correct as well as understanding the *logical sequence of the arguments*. Second, you try and use intuition and/or pictures, to get a feeling *why a result must be true* and why the proof strategy used is *the right one/makes sense*. In this stage, it helps to connect the result and its proof method to previously learned concepts or proofs or proof-arguments. Third, you try and reproduce the proof with *closed book*. This does not mean learning the proof by heart! It means, you can *recover through intuition and experience the strategy of the proof and actually execute its steps.* If you have some coding experience to the level of writing non-trivial programs, it helps to think of proof-writing as a bit like coding: every part of a proof must be correct and make sense for the whole proof to succeed, just as every part of the code must be correct for the whole program to execute its task correctly.

Grading Policy: Problem sets (40%), Three 'small' exams of 20% each. Exams will focus on disjoint parts of the material. Format of exams will be announced soon.

On Problem Sets: They are assigned weekly and due the following week at the beginning of the second class of the week. Hand them in electronically on Canvas (details to be announced on Canvas).
Very important: Please always type your solutions in TeX/LyX. No hand-written solutions are allowed. This will help you getting accustomed with typing down your research ideas and work in Tex/Lyx early on, which will turn out to be really helpful for your research.

Discussion with other students is allowed and encouraged, but you must write up each assignment individually and without the help of other students.

Important Dates:

Exam 1 (30 min - one hour, tbd) in the week after the topic dynamic programming with infinite horizon is finished.
Exam 2 (30 min - one hour, tbd) in the lecture/recitation after the topic dynamical systems is finished
Exam 3 (30 min - one hour, tbd) in the lecture/recitation after the last topic.

Recitations: Recitation sessions are an important part of the course, because they provide an opportunity to review the material and deepen its understanding. These sessions will be used to solve the exercises related to the topics covered in the lectures. In the spirit that 'you learn better through learning-by-doing', students may be asked to solve or contribute for the solution of certain exercises from the problem sets in the white/blackboard. Questions on the course material and especially on the problem sets, may also be discussed during recitations.

Academic Integrity:

- Cheating/plagiarism is not tolerated. Students suspected of violating the University of Pittsburgh Policy on Academic Integrity, from the February 1974 Senate Committee on Tenure and Academic Freedom reported to the Senate Council, will be required to participate in the outlined procedural process as initiated by the instructor. A minimum sanction of a zero score for the problem set or exam will be imposed. View the complete policy at `www.cfo.pitt.edu/policies/policy/02/02-03-02.html`
- Sharing class materials, including problem sets and exams on the internet is a violation of academic integrity.

Disability Services: If you have a disability for which you may be requesting an accommodation, you are encouraged to contact me and also the Office of Disability Resources and Services, 140 William Pitt Union, 412-648-7890/412-624-3346(Fax), as early as possible. For more information visit `www.studentaffairs.pitt.edu`.

Acknowledgment: I am very grateful to Sofia Moroni and Benjamin Matta for giving me access to their materials from previous versions of this course.