Mathematics Review Course

University of Minnesota
Department of Applied Economics

Summer 2023

Instructor:	Ryan McWay	**Time:**	MTWRF 9:00 – 12:00 CT
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Course Pages:

1. Primary Github Repository: `https://github.com/mcwayrm/apec_math_review_2023`
2. Canvas Site: `https://canvas.umn.edu/courses/401319`

Office Hours: After class, or you may reach out directly via email. Discussing math in-person or over zoom is preferred to email.

Course Description: This is a survey course for graduate-level mathematics skills for masters and doctoral students entering the Applied Economics (APEC) program in the Fall, 2023. Additionally, this course is open to similar incoming students from adjacent fields (Public Policy, Business, Health Economics, etc.). Concepts are likely a mixture of material students will be familiar with as well as novel methods and applications necessary for success in this program. As these Nobel Laureates will tell you, math is an important component for modern economic analysis. Through recitation and practice problems, this course will prepare students for the mathematical rigor of the core microeconomics theory (APEC 8001 – 04) and econometrics (APEC 8211 – 14) during the first-year sequence. Additionally, we will briefly cover concepts useful for macroeconomic theory (ECON 8105 – 8108). Generally, we will cover the following broad categories of mathematics with application to the economic sciences: set theory, topology, probability, statistics, algebra, calculus, proofs, linear algebra, and optimization.

This is a non-credit course. The course content consists of lectures, encouraged readings, supplementary reinforcing materials, and optional problem sets. This course will be offered in a hybrid format (in-person and online). I encourage in-person attendance.

The best way to learn and reinforce mathematics is to practice math ... not just to digest lectures on mathematics. Therefore, the structure of this course is to introduce material you have both seen before and likely not seen before. Clarify this material and demonstrate both applications in economics as well as through exercises in class. Active participation by students will be required (both in-person and via zoom) to attempt these exercises. These exercises are reinforced through at-home problem sets for students' individual practice. Only by doing will you (the student) grasp concepts wholly and feel comfortable applying this knowledge.

As a primer before starting this course, I would suggest watching Steven Hamilton's 'Surviving Math Camp' video. There are many reviews of what to expect when expecting (e.g., starting a PhD). Two of these I will highlight that may be useful are EconJohn's video as well as Cornell's Economic Department guide for advice and studying in the first year. With minimal effort, you can find several other videos, blogs, and resources on surviving your first year in an economics PhD.

This course has been structured with consultation of the APEC department chair (Terry Hurley), the APEC graduate director (Terry Hurley), along with the material from instructors for the microeconomics series (Paul Glewwe, Rodney Smith, Steve Polasky, Jay Coggins) and the econometrics series (Joe Ritter, Paul Glewwe, Marc Bellemare). The initial teaching assistants for microeconomics (Matthew Braaskma) and for econometrics (Shunkei Kakimoto) have reviewed this course material. The course content relies heavily upon previous instruction of this review course by Mwaso Mnensa (2022), Matthew Bombyk (2021), Ling Yao (2020), Natalia Ordaz Reynoso (2019), and Vanee Dusoruth (2017, 2016).

Main References: This is a restricted list of various interesting and useful books that will be touched upon during the course. You need to consult them occasionally. These materials are readily available through internet archives, online bookstores, the university bookstore, as well as the department library (Waite Library). Books marked with (†) are useful references for you as an economist, but will not be directly assigned as readings in this course.

Mathematics:

- [SB] Simon, and Blume. (1987). *Mathematics for Economists.*
- † [Chiang] Chiang. (2004). *Fundamental Methods of Mathematical Economics.*
- [Hammack] Hammack. (2013). *Book of Proof.*
- † [Velleman] Velleman. (2006). *How to Prove It: A Structured Approach.*
- [B&S] Bartle, and Sherbert. (2010). *Introduction to Real Analysis.*
- [Hansen Stats] Hansen. (2022). *Probability and Statistics for Economists.*
- † [D&S] DeGroot, and Schervish. (2012). *Probability and Statistics.*
- † [Strang] Strang. (2006). *Linear Algebra and Its Applications.*

Microeconomics:

- [MWG] Mas-Colell, Whinston, and Green. (1995). *Microeconomic Theory.*
- [Sundaram] Sundaram. (1996). *A First Course in Optimization Theory.*

Macroeconomics:

- [Stokey] Stokey, Lucas, and Prescott. (1989). *Recursive Methods in Economic Dynamics.*

Econometrics:

- [Hansen Metrics] Hansen. (2022). *Introduction to Econometrics.*
- † [Kennedy] Kennedy. (2008) *A Guide to Econometrics.*
- † [Greene] Greene. (2017) *Econometric Analysis.*

Supplementary Courses:

This is not the only math review for economics that is available to you. Several well curated courses have been made available from other departments that may be of interest to you. Below are a list of supplementary courses that you may review or reference at your leisure. Reference them at your discretion.

- University of Arizona's ECON 519 Course
- University of Arizona's Math Camp YouTube videos
- University of California, Irvine's open course in Math for Economists
- University of California, San Diego's Essential Mathematics for Economists
- University of California, Berkeley's ARE 201 Course
- University of California, Berkeley's ECON 204 Course as well as this alternative version by Robert Anderson
- University of Pittsburgh's ECON 2001 Course

Objectives: By the end of the course, students should be able to:

- Identify areas of weakness in mathematics, and be able to address them through individual study, practice, and seeking assistance appropriately.
- Understand the fundamentals of mathematics applications in economics.
- Comfortably perform proofs and optimization.
- Comfortably perform problem sets under time constraints.
- Confidence starting the first year sequence.

Important Dates:

Start of Math Review Course	August, 7th
Start of Coding Review	August, 14th
End of Coding Review	August, 14th
End of Math Review Course	August, 25th
APEC Graduate Student Orientation	August, 30th & 31st
Start of Fall 2023 Academic Semester	September, 5th

Problem Sets:

This course is optional and not graded. To reinforce material, and to determine for yourself deficiencies in your math background worth improving, daily problem sets will be assigned corresponding with the material covered in each lecture. Completing these problem sets is optional and will not be graded. But it is highly encouraged. If you are struggling, this helps me identify the issue with better clarity.

Problem sets may be completed in groups, but are strongly encouraged to be first attempted individually. I highly recommend creating cohorts or study groups to assist with questions and comprehension of the material. You will likely rely upon them in future coursework.

Solution sets will be made available via the Github repository the following day.

Tentative Course Outline:

The chronology of topics is subject to change. Lecture slides are available on the Github repository. Encouraged readings are intended to be reviewed before the lecture. Supplementary material should be referenced as necessary following the lecture. Assignments are intended to be completed following the assigned lecture prior to the next lecture period.

Lecture		Topic	Encouraged Reading	Supplementary Material	Assignment
1	Aug. 7	Logic & Proofs	B&S App. A	Hammack Ch. 1 & 2	PS01
			Hammack Ch. 4 & 10	B&S Ch. 1 & 2	
				S&B Ch. A1.3	
2	Aug. 8	Sets & Topology	B&S Ch. 11	MWG App. M.G.	PS02
			S&B Ch. 12	S&B Ch. A1.1	
3	Aug. 9	Derivatives	MWG App. M.A.	Sundaram Ch. 2	PS03
			B&S Ch. 6		
4	Aug. 10	Integration	S&B Ch. 2, 3, & 4	S&B Ch. A4	PS04
5	Aug. 11	Multi-variate Calculus	S&B Ch. 14, 15, & 20	...	PS05
6	Aug. 14	Matrices	MWG App. M.D., & M.M.	Sundaram Ch 1.3	PS06
7	Aug. 15	Linear Algebra	S&B Ch. 7, 8, & 9	Hansen Metrics Ch A18,	PS07
				A19, & A20	
8	Aug. 16	Numbers & Functions	Hammack Ch. 12	Sundaram Ch. 7 & 8	PS08
			MWG App. M.B. & M.C.	B&S Ch. 3, 4, & 5	
			MWG App. M.F. & M.I.	S&B Ch. 13, & 21	
9	Aug. 17	Optimization	MWG App. M.J., & M.K.	Sundaram Ch. 2, & 4	PS09
10	Aug. 18	Optimization	MWG App. & M.L.	Sundaram Ch. 5, & 6	PS10
			S&B Ch. 17, 18, & 19		
11	Aug. 21	Probability	Hansen Metrics Ch. 1 & 2	...	PS11
12	Aug. 22	Statistics	Hansen Metrics Ch. 6, 7 & 8	...	PS12
13	Aug. 23	Time Series &	MWG App. M.N.	Sundaram Ch. 11 & 12	PS13
		Dynamic Programming	Stokey Ch. 3, 4, & 10		
14	Aug. 24	Ancillary Material	...	...	...
15	Aug. 25	Coursework Preview	...	...	...
		& Review			

Course Policy:

- Course content is subject to change (including during the course period). You should expect lecture slides to be in-progress until immediately before the start of the scheduled lecture. Major changes will be publicly announced. Refer to the Github repository for an updated syllabus and material as needed.
- Enrollment will be determined via the list of participants provided the instructor through the APEC department. If you wish to be added, consult your program coordinator.
- The course material is the instructor's intellectual property. Dissemination is at the discretion of the instructor – Ryan McWay.

Class Policy:

- Regular attendance is essential and encouraged, but is optional. Attendance will be recorded.
- A regular zoom link will be available for remote access to this course. The link will be sent out via email. You may request the link via email if you have not received it.
- Lectures will not be recorded. If you wish to learn, attend the live session. Conflicting commitments may be seen as a minor inconvenience, as this course is a non-requisite for your graduate studies.
- Respect for your fellow classmates and the instructor is expected while in the classroom. You will be asked to leave if you are inconsiderate of your peers, or are disrupting the learning process.