

Mathematical Economic Analysis

(Econ 705, Fall 2026)

Professor: Alan G. Isaac
Office: Zoom (via Canvas)
Hours: F9–12, by appt

TA: Noah Lansing
Office: Zoom (via Canvas)
Hours: W 3pm–5pm, by appt

Overview

Learning Outcomes

This course is an introduction to mathematical methods used by economists. These are basic mathematical tools needed for advanced study in economics. Students who master the material will be able to understand and solve problems related to:

- types of functions in economic models.
- composition of functions.
- sets and methods of proof.
- linear models and matrix algebra.
- comparative static analysis of the predictions of linear models.
- differential calculus for approximation and optimization.
- comparative static analysis of non-linear models.
- univariate and multivariate optimization.
- comparative dynamic analysis.
- some computer applications of mathematical methods to economic analysis.

Every class differs in background preparation and interests. I will depend on your classroom feedback to set the class pace and the depth of coverage of certain topics, so be sure to ask questions in class.

Course Prerequisites

A college-level calculus course is prerequisite to this course. I assume you remember basic differential calculus from the first semester and a little bit about integration. Ideally you also recall some matrix algebra or linear algebra, but we start from scratch with these topics.

Textbooks

This is not a textbook based course. However, it draws fairly directly on many chapters of [Hoy et al. \(2022\)](#) and a few core chapters of [Fuchs \(2023\)](#). Homework often refers to these textbooks, and I strongly recommend acquiring them. In addition, you need to learn a bit of the Wolfram Language for your homework assignments, and [Wolfram \(2024\)](#) is a good place to start with that project.

Mathematics for Economists [Hoy et al. \(2022\)](#) (4th edition only!)

Introduction to Proofs and Proof Strategies [Fuchs \(2023\)](#) (The Kindle version is inexpensive and may be read and annotated on computer with the Kindle app.)

An Elementary Introduction to the Wolfram Language [Wolfram \(2024\)](#) (available free online)

A single copy of [Hoy et al. \(2022\)](#) is available in the library. It is a shared copy and therefore may not be available when you need it.

- go to the [Library website](#), and enter “Hoy Livernois” in the search
- click on the 2022 edition where it says “Available online”, and click “View Online”
- click on a tiny **go to** symbol (to the right of View License) in order to get to the resource

Course Policies

Homework Policies

Submission Homework assignments must be submitted *on time* via Canvas. Late submission incurs a grade penalty. Early submission is welcomed.

Computer problems are not an excuse for late submission: be sure to use autosave and to back up to the cloud.

Professionalism Homework **must** be typed into a [Mathematica](#) notebook. At the top of each assignment, include your name, a course identifier, the assignment number, and your ethics statement.

Collaboration with AI As described on the homework assignments, some use of AI is permitted if carefully documented in your assignment.

Collaboration with Others You may discuss the homework with others, but the *write up* must be *entirely independent*. In particular, it is an Academic Integrity violation to either copy solutions *or* to provide solutions to be copied. (See the homework assignments for more details.) Be sure to cite any helpful discussions in writing on your assignment.

Grading Homeworks submissions are graded by the TA. You may request supplementary comments from the TA, but do not request grade changes. If you wish to contest a homework grade, submit your homework to me for regrading of the *entire assignment*. Regrading may produce a score reduction.

Note: During the day, you may be able to request access to the Economics Department lab, which has a few copies of Mathematica installed.

Exam Policies

Mastery Exams are taken in class without access to a textbook or computer. No collaboration is allowed.

Illness or Emergency As a general rule, this course does *not* offer makeup exams.

If you miss an exam due to unavoidable contingencies, such as illness or family emergencies, please obtain an excused absence from the Dean of Students. Your overall examination grade will then be calculated from the remaining exams.

Online Communication

Core Resources This class uses [Canvas](#). Look there for the syllabus, lecture supplements, and assignments.

Announcements and Discussions I use Canvas Conversations (Inbox) for individual communications. I post homework and exam related announcements on Canvas. Students **must** monitor these announcements. Students should also **subscribe** to the Canvas Discussions, which often contain additional homework guidance.

Etiquette In any online discussion, be sure to be respectful, and quote appropriately.

IRL Classroom Policies

Safety Stay home if you feel sick or test positive for a contagious disease. (I will provide my lecture notes or slides.) Be sure to follow any [posted health guidelines](#), which are updated in response to local conditions. If masks are required, wear your mask snugly over *both* the nose and mouth, and use a high-quality mask (e.g., KN95). Surgical masks are *not* adequate.

Phones Silence your phone before entering the classroom. (E.g., set it to vibrate, or turn it off.) Place it *out of sight* in a pocket or bag (and **not** on your desk). If you need to make or take a call, you may quietly leave the classroom. (Please sit near the door if you anticipate such a need.)

Computers Do not browse the web or check for messages during class. Such activities distract others and reduce your ability to contribute to classroom discussions. You may use a computer to take notes or do other course-relevant activity. However, [Sana et al. \(2013\)](#) find that using a computer to take notes can hinder learning, apparently due to the distraction of multitasking. [May and Elder \(2018\)](#) find that although students believe themselves capable of productive multitasking, in fact they are not.

Assessment and Grading

Assessment

I assess student mastery of the learning outcomes (see above) by means of graded exams, graded homework, and ungraded class participation.

Exams

Exams are graded. Success on exams requires a thorough mastery of the homework material. See our Canvas course site for the midterm exam date. The official [final exam schedule](#) *always* determines the date and time of the final examination. **Caution:** Answers I cannot read are graded as incorrect.

Homework

Homework is graded for completeness, correctness, and professionalism. It must be typed in Mathematica and then submitted on Canvas in PDF format.

Class Participation

Class participation includes both in-class participation and asynchronous participation in online discussions. Both are used for ongoing assessment of student mastery of this course's learning outcomes (listed above). I use your in-class participation to provide immediate feedback, with the goal of enhancing mastery of student learning outcomes. So be sure to ask questions! Note that although class participation is ungraded, active participation is very much expected.

Grading

Homework and exams are graded.

Points

Your course grade is based on your total weighted points earned. (See below.) There is no “extra credit”. Assessments contribute to points earned as follows:

- homework (20 percent of weighted points),
- midterm exam (35 percent of weighted points),
- cumulative final exam (45 percent of weighted points).

Cutoffs

The numerical cut-off points for grades are standard, e.g., 90% for A-range grades and 80% for B-range grades. (Cutoffs are sharp; grades are not rounded upwards.) It follows that in principle every student can attain a grade of A, if every student’s performance is exceptional.

Curving

If numeric scores are unusually low in an otherwise attentive class, I curve the grades. Specifically, if fewer than 15% of the class reaches the 90% cutoff, I will lower all cutoffs until at least 15% of the grades are A or A-.

Topics and Readings

The suggested timing of topics and the extent of coverage is tentative and may be revised as the semester progresses. The number of classes designated below for each topic is intended only as a rough guide: class interest and preparation will determine how quickly we progress through the topics. For each topic, find additional required readings and useful videos on Canvas. New readings may be added to the during the course. Resources listed as recommended are *entirely* optional.

Consider reviewing the following topics before the beginning of classes. (These textbooks should be available at the Reserve Desk.) For **Informal Logic and Proof Strategies** read [Fuchs \(2023, ch. 3\)](#). For **Functional Forms** (including exponents and logarithms), read [Hoy et al. \(2022, ch. 2.4\)](#). and [Hughes-Hallett and others \(2021, ch. 1\)](#).

Background Reading

Week 0 (read before class starts)

Informal Logic and Proof Strategies

[Fuchs \(2023, ch. 3\)](#) covers basic proof strategies.

Integers and Divisibility

[Fuchs \(2023, ch. 6\)](#) explores the integers.

Sets, Functions, and the Field Axioms

[Fuchs \(2023, ch. 2\)](#) reviews the common set operations and presents the field axioms.

Functions and Equations

Week 1

Functions

[Hoy et al. \(2022, ch. 2.2, 2.4\)](#) covers common functional forms, level sets, and the concept of concavity.

Time-Value of Money

Week 2

Present Value

[Hoy et al. \(2022, ch. 3.3\)](#)

Sequences

Week 3

Sequences, Series, and Limits

[Hoy et al. \(2022, ch. 3\)](#)

Sequences

[Simon and Blume \(1994, ch.12 \(Sequences\)\)](#)

Mathematical Induction

[Fuchs \(2023, ch. 4\)](#)

Review Resources

- *Preview of the Formal Definition of a Limit*, [Hughes-Hallett and others \(2021, ch. 1.10\)](#).
- *Sequences and Series*, [Hughes-Hallett and others \(2021, ch. 9\)](#).

Function Limits and Continuity

Week 4

Continuity of Functions

[Hoy et al. \(2022, ch. 4\)](#)

Limits and Continuity

[Fuchs \(2023, ch. 9\)](#)

Review Resource

Review the material on univariate differential calculus from your previous calculus course.

Dynamical Systems (Univariate)

Week 5

Fixed Points

Video: <https://www.youtube.com/watch?v=csInNn6pfT4&t=125s>

Derivatives and Differentials (Univariate)

Week 6

Univariate Derivatives, Differentials, Taylor Series

[Hoy et al. \(2022, ch. 5\)](#)

Review Resources

- *The Derivative*, [Hughes-Hallett and others \(2021, ch. 2\)](#).
- *Short-Cuts to Differentiation*, [Hughes-Hallett and others \(2021, ch. 3\)](#).
- Taylor Series (video) <https://www.youtube.com/watch?v=KoCk1krAX2M>

Univariate Optimization

Week 6

Univariate Optimization

[Hoy et al. \(2022, ch. 6\)](#)

Review Resource

Using the Derivative, Hughes-Hallett and others (2021, ch. 4).

Functions on Vector Spaces

Week 7

Linear Equations and Vector Spaces

[Hoy et al. \(2022, ch. 7\)](#)

Preview of Linear Algebra

[Fuchs \(2023, ch. 11\)](#) (on reserve).

Week 8: Midterm (approximately here)

Elementary Equation Operations

Week 9

Matrices

[Hoy et al. \(2022, ch. 8, 9.1\)](#)

Review Resource

A Fundamental Tool: Vectors, Hughes-Hallett and others (2021, ch. 12).

Determinants and Inverses: Some Details

Week 10

Determinants and Inverses

[Hoy et al. \(2022, ch. 9\)](#)

The Comparative Statics of Linear Models

Week 10

Review Resources

[Hoy et al. \(2022, ch. 9 \(review\)\)](#)

Multivariate Calculus and Nonlinear Comparative Statics

Week 11

Multivariate Calculus

[Hoy et al. \(2022, ch. 11\)](#)

Comparative Statics

[Hoy et al. \(2022, sec. 14.1 & 14.2\)](#)

Second-Order Partial Derivatives

[Hoy et al. \(2022, ch. 11 section 2\)](#) (repeat)

Concavity and Convexity

[Hoy et al. \(2022, sec. 11.5\)](#)

Review Resources

- [Functions of Several Variables, Hughes-Hallett and others \(2021, ch. 12\)](#).
- [Differentiating Functions of Several Variables, Hughes-Hallett and others \(2021, ch. 14\)](#).

Eigensystems

Week 12

Eigensystems

[Hoy et al. \(2022, ch. 10.1\)](#)

We may not have much time to discuss eigensystems.

Quadratic Forms

Week 13

Quadratic Forms

[Hoy et al. \(2022, ch. 10.2\)](#)

Multivariate Optimization

Week 13

Multivariate Optimization

[Hoy et al. \(2022, ch. 12\)](#)

Quasi-Concavity

[Hoy et al. \(2022, sec. 11.6\)](#)

Review Resource

[Optimization: Local and Global Extrema, Hughes-Hallett and others \(2021, ch. 15\)](#).

Constrained Multivariate Optimization

Week 14

FONCs for Constrained Multivariate Optimization

[Hoy et al. \(2022, ch. 13.1\)](#)

Second-Order Conditions for Constrained Multivariate Optimization

[Hoy et al. \(2022, ch. 13.2\)](#)

Advanced Multivariate Optimization (Optional)

If time permits, I will cover some of these topics. However, you are not responsible for them

More Constrained Multivariate Optimization

[Hoy et al. \(2022, ch. 13.3\)](#)

Envelope Theorem

[Hoy et al. \(2022, ch. 14.3\)](#)

Kuhn-Tucker Conditions

[Hoy et al. \(2022, ch. 15\)](#)

References

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- Hughes-Hallett, Deborah, and others. 2021. *Calculus: Single and Multivariable*. 8th ed. Wiley.
- Lukianoff, Greg, and Jonathan Haidt. 2018. *The Coddling of the American Mind: How Good Intentions and Bad Ideas Are Setting up a Generation for Failure*. Penguin Books.
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- Mueller, Pam A., and Daniel M. Oppenheimer. 2014. "The Pen Is Mightier Than the Keyboard: Advantages of Longhand over Laptop Note Taking." *Psychological Science* 25 (6): 1159–68. <https://doi.org/10.1177/0956797614524581>.
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- Sana, Faria, Tina Weston, and Nicholas J. Cepeda. 2013. "Laptop Multitasking Hinders Classroom Learning for Both Users and Nearby Peers." *Computers and Education* 62 : 24–31. <https://doi.org/10.1016/j.compedu.2012.10.003>.
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- Urry, H. L., C. S. Crittle, V. A. Floerke, et al. 2021. "Don't Ditch the Laptop Just yet: A Direct Replication of Mueller and Oppenheimer's (2014) Study 1 Plus Mini Meta-Analyses across Similar Studies." *Psychological Science* 32 (3): 326–39. <https://doi.org/10.1177/0956797620965541>.
- Wolfram, Stephen. 2024. *An Elementary Introduction to the Wolfram Language*. 3rd ed. Wolfram Media. <https://www.wolfram.com/language/elementary-introduction/2nd-ed/>.

This syllabus intentionally lacks trigger warnings. While a university education should be physically safe, it should be intellectually perilous (Lukianoff and Haidt 2018; Bridgland et al. 2024). For the views of the American Association of University Professors, see their 2014 report entitled *On Trigger Warnings*. Any student who finds this lack of trigger warnings personally threatening can contact [AU's Well-Being Center](#) for counseling and support.

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Study Strategies

- Follow the [Tips for Academic Success](#).
- Put away your phone. [Evidence](#) keeps accumulating: the simplest step to improve your work and school performance is sustained time away from your phone and especially any social media. Of course, overcoming [addiction](#) is conceptually simple, but it may not be easy to achieve. (Especially when unrecognized.)
- Participate in discussions. [Romer \(1993\)](#) finds that attendance improves performance.
- Take good notes. Good notes will be crucial to your performance on the examinations. Some studies suggest that taking notes by hand is more effective than taking them on your laptop (e.g., [Mueller and Oppenheimer \(2014\)](#) and [Mueller and Oppenheimer \(2018\)](#)). I consider this plausible, although at least one replication attempt failed [Urry et al. \(2021\)](#).
- Do not reserve your studying for the weekends. I suggest at least an hour of studying per day, every day. Daily exposure is much better than cramming.
- Study someplace that is not distracting. Put your connected devices completely out of view and out of reach.
- Do the required reading. I draw on the required readings for exam questions.
 - Don't read it just once.
 - If you own your textbook, read with a highlighter or pencil.
 - Outline the important points.
 - Make flashcards for key vocabulary and concepts. (Collaborate with other students on this!)
- Do end of chapter problems. I may develop exam questions based on these problems.
- Students who form study groups tell me that these are very helpful. (You may use the Canvas email function to search for study partners.) Make up problems in your study group as part of exam preparation.
- Discuss readings and problems on in the Canvas discussion forum. Don't let your questions go unanswered!
- Ask questions. If you feel timid about stating your question in public, email it directly to me or to a TA. Don't let your questions go unanswered!

Required and Recommended Syllabus Sections

The following sections are required or recommended on all syllabi at American University. The language is unaltered from suggestions provided by the administration.

Academic Support and Access Center (ASAC) MGC 243, 202-885-3360.

All students may take advantage of the Academic Support and Access Center (ASAC) for individual academic skills, counseling, workshops, tutoring and writing assistance, as well as Supplemental Instruction. All services are free. The services include the Writing Center (first floor of Bender Library), which assists students with academic writing and assignments. The Math/Stat Lab (Myers Building, 202-885-3154) which provides mathematics and statistics tutoring. Additional content tutoring is also available in the ASAC's Tutoring Lab.

Students with Disabilities

American University is committed to making learning and programming as accessible as possible. Students who wish to request accommodations for a disability, must notify me with a letter of approved accommodations from the ASAC. As the process for registering and requesting accommodations can take some time, and as accommodations, if approved, are not retroactive, I strongly encourage students to contact the ASAC as early as possible. For more information about the process for registering and requesting disability-related accommodations, contact ASAC.

Academic Integrity

Standards of academic conduct are set forth in the University's [Academic Integrity Code](#). By registering for this course, you have acknowledged your awareness of the Academic Integrity Code and your obligation to become familiar with your rights and responsibilities as defined by the code. Violations of the Academic Integrity Code will not be treated lightly, and disciplinary actions will be taken should violations occur. The standard sanction for violations is failure of the course.

Emergency Preparedness

In the event of a declared pandemic (influenza or other communicable disease), American University will implement a plan for meeting the needs of all members of the university community. Should the university be required to close for a period of time, we are committed to ensuring that all aspects of our educational programs will be delivered to our students. These may include altering and extending the duration of the traditional term schedule to complete essential instruction in the traditional format and/or use of distance instructional methods. Specific strategies will vary from class to class, depending on the format of the course and the timing of the emergency. Faculty will communicate class-specific information to students via AU e-mail and Blackboard. Students are responsible for checking their AU e-mail regularly and keeping themselves informed of emergencies. In the event of a declared pandemic or other emergency, students should refer to the AU Web site (american.edu/emergency) and the AU information line at (202) 885-1100 for general university-wide information, as well as contact their faculty and/or respective dean's office for course and school/college-specific information.

Sharing of Course Content

Students are not permitted to make visual or audio recordings, including live streaming, of classroom lectures or any class related content, using any type of recording devices (e.g., smart phone, computer, digital recorder, etc.) unless prior permission from the instructor is obtained, and there are no

objections from any of the students in the class. If permission is granted, personal use and sharing of recordings and any electronic copies of course materials (e.g., PowerPoints, formulas, lecture notes and any classroom discussions online or otherwise) is limited to the personal use of students registered in the course and for educational purposes only, even after the end of the course.

Exceptions will be made for students who present a signed Letter of Accommodation from the Academic Support and Access Center. See: [How Do I Request Accommodations?](#)

To supplement the classroom experience, lectures may be audio or video recorded by faculty and made available to students registered for this class. Faculty may record classroom lectures or discussions for pedagogical use, future student reference, or to meet the accommodation needs of students with a documented disability. These recordings are limited to personal use and may not be distributed (fileshare), sold, or posted on social media outlets without the written permission of faculty.

Unauthorized downloading, file sharing, distribution of any part of a recorded lecture or course materials, or using information for purposes other than the student's own learning may be deemed a violation of American University's Student Conduct Code and subject to disciplinary action (see Student Conduct Code VI. Prohibited Conduct).