Math 190 – Mathematics of Sustainability, Spring 2026 – Course Syllabus

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Lectures:
Monday, Wednesday, 11:30 AM - 12:45 PM, Math & Science Center (MSC)- N301

Some Important Dates and Times:

Jan 27:	A/D/S ends
Mar. 20:	Last Day to W or change grade
Apr. 1:	**Midterm Exam: GT and LP**
Apr. 27:	Last Day of Class
May 6:	**Final Presentation: SP (Wednesday, 11:30 - 2:00 PM)**

Office Hours:
Instructor: Will be formally decided the first week of class, but tentatively Monday, Wednesday, 3:00 PM-4:00 PM MSC N412

Students are always welcome to email the instructor directly to ask questions or to request an appointment.

Prerequisites: Prior calculus experience, Math 111, AP credit for Calculus AB or BC, transfer credit from Calculus I at a different institution is preferred. Contact the course instructor if you have any questions.

Learning objectives:

In this course, students will learn the complex dynamics of the environment in terms of ecological networks, economic games, linear programming optimization, and data visualization. This course is designed for first year students to get a taste of upper level mathematics that are not traditionally taught as math courses at Emory. The disparate topics will be connected by their focus on the environment as well as interdisciplinary studies. Hopefully, the connections become clear, and the definition of sustainability transcends just green spaces and recycling.

While it is easy to say "companies should just go green" or "people are silly for not recycling", we try to contextualize these behaviors using *operations research* (sometimes called OR), i.e. how do businesses and rational consumers actually think? We explore decisions, games, optimization, and states as mathematically rigorous objects.

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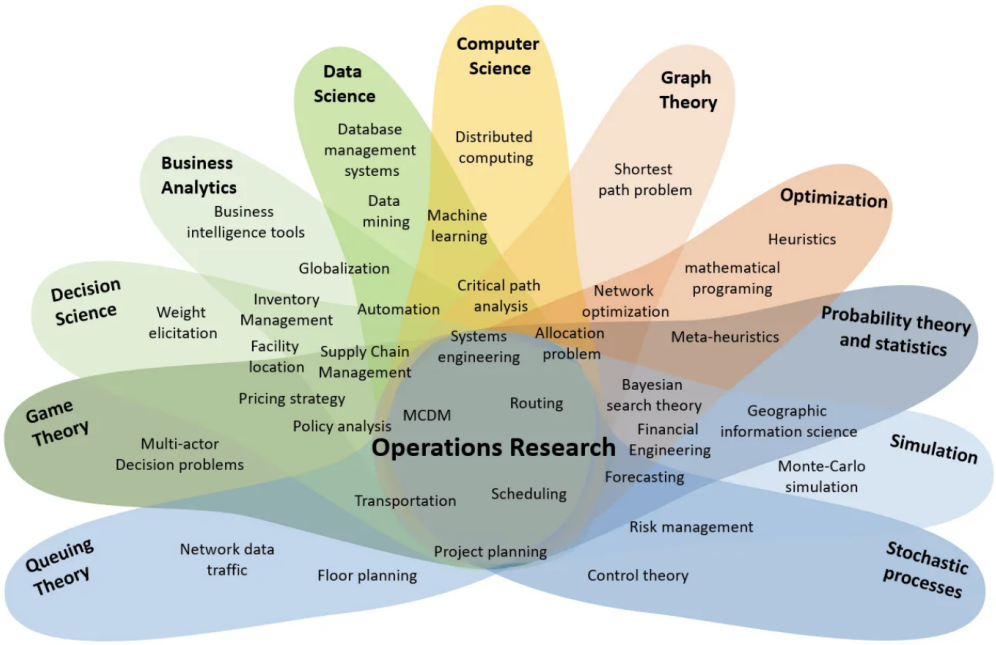

Figure 1: Interdisciplinary depiction of Operation Research (OR), by Alex Elkjær Vasegaard.

Textbook

- **Textbooks:**
  - *Game Theory: An Introduction*, by Steven Tadelis (GT)
  - *Elementary Linear Programming with Applications* by Bernard Kolman, Robert E. Beck (LP)
  - *Essentials of Stocahstic Processes*, by Rick Durrett (SP)
- **Content:** We will cover GT first, particularly, selected ideas from Chapter 1 to 7, then LP, specifically Chapter 1, and lastly, SP, with Chapter 1, Sections 1 - 5. A tentative schedule of what we will cover is provided on the final page of this syllabus.
- **Online Resources:** While it might look like there are many books, we really only select one core idea from each book (LP and SP) or a cursory look at many different topics (GT). Additionally, I was a student once as well, so all of these books are freely available as a PDF online. Additionally, the important chapters will be available on Canvas and the course website.

Course Structure

- **Lectures:** There will be two lectures each week on Mondays and Wednesdays from 11:30 AM-12:45 PM. You are expected to attend lectures. All the lecture notes will be posted before the start of each week. Lecture notes are self-contained and include enough examples. Both lectures will follow these notes.

  The lectures are divided into the following modules

  1. **Module 1:** Game Theoretic Properties of Sustainability – In terms of making positive change, one must first understand how individual people make decisions, as well as how two interacting parties make decisions

based on maximizing their individual objective. We explore single person decision problems, static and dynamic two person games, Nash equilibria, strategy types, and what games of complete and incomplete information look like in the real world.

2. **Module 2:** Optimization for Sustainable Business – Businesses strive to maximize profit and minimize cost, but there are certain constraints such as supply shortages, that have to be considered. We explore how companies use a simple model to ensure they are making the most profit given these constraints. We discuss the system of linear programming, software to solve it, and the mathematics of optimization.
3. **Module 3:** Markov Chains for Ecological Networks – Sustainability is full of complicated networks of give and take, where there can be long run effects from decisions that are made. We explore these ecological networks from the perspective of Markov chains. We first discuss probabilities and graph/ matrix representations of these complex networks. Then we explore what happens when our model advances many steps, as well as long run behavior of our systems. We also classify parts of our network qualitatively to understand which outcomes are never possible.

- **Discussion Forum:** It's likely that you will have questions as you review your notes and complete homework assignments. Those that occur to you will likely also occur to other students. You can ask questions on Canvas Discussion Module.

Assessments

- **Grade Distribution:** Grades will be distributed as follows:

Homework	20%	7 assignments, 2 lowest grades dropped
Midterm	15%	1 exam
Projects	60%	3 projects, equally weighted
Participation	5%	discussions, asking questions, OH, etc.

Your final grade will be based on a weighted average of all assessed components. There might be an upward adjustment to ensure that the class average aligns at least with a B grade. For every assignment and exam, we will provide the class median, mean, and standard deviation, offering you a clearer understanding of your position. The number of points you earn will be mapped to a letter grade as follows:

A: [93, 100]	A-: [90, 93)	B+: [87, 90)	B: [83, 87)	B-: [80, 83)	C+: [77, 80)
C: [73, 77)	C-: [70, 73)	D+: [67, 70)	D: [63, 67)	D-: [60, 63)	F: [0, 60)

- **Homework:**
  - You will have two homeworks per module and one homework at the beginning to set expectations of the material. There will be 7 total homework assignments. The assignments will be posted on and submitted through Canvas. The homework will be due on Wednesday at 11:30 am, which is the beginning of class, (except for holidays) and will be posted no later than three classes beforehand (Monday the week prior). The number of questions may vary week to week, but the assignments will not be very long. You will upload your written homework to Canvas in PDF format to grade.
  - The lowest two homework grades will be dropped. **No makeup assignments will be given.** If you have to miss an assignment, it will be one that is dropped.

  - Homework assignments will be graded on an individual basis. The instructor allows discussions with other students while solving the problems. The only requirement is that you acknowledge all contributors and sources used. Yes, this does include large language models such as ChatGPT. Identical solutions that are seen as Honors Code violations, will not be graded and will be reported to the Honor Council. The border between acceptable and unacceptable collaboration may be subtle. If you are uncertain whether a particular behavior is acceptable or not, please ask the instructor or teaching assistant as soon as possible.

- **Exams:**
  - There will be **one midterm exam** given in class, on **Apr. 1** (and no this isn't an April's Fool situation lol). You will be given the full class period (75 minutes) to take the midterm.
  - The **final exam** will be a final presentation to your Module 3 project. It will take place during final week on Wednesday, **May 6, from 11:30 AM to 2:00 PM**.
  - Conflicts with the final exam time slot must be reported through the Office for Undergraduate Education (OUE). You must notify the instructor at least two weeks before the exam date if you have a conflict, or have a valid excuse verified by the Office of Undergraduate Education (OUE).

- **Projects:**
  - There will be 3 module projects, which will be a combination of individual and small group projects. There will be a written and oral portion of each project. No project is dropped, and each are weighted equally, i.e. each project is 20% of your final course grade.
  - These projects allow us the flexibility to apply the mathematical topics from class in the broader context of environmentalism, sustainability,
  - There will be some class time dedicated to each project, but most work will have to be done outside of class time.

- **Participation:**
  - During the semester, there will be several ways to participate in the course.
  - Attending lectures and office hours, answering discussion questions posed on Canvas, taking practice quizzes, asking me questions, and more are ways of measuring your participation.
  - Just be an active participant in the course!

Emory University Academic Rules

- **Academic Integrity:**

  By participating in this course, you are accepting the Emory Honor Code. Instructors are obligated to report violations to the rules of the honor code.

- **Policy on use of AI and Academic Integrity:**

  There are many good reasons to not use artificial intelligence and large languages models such as ChatGPT. There are numerous resources available to you that, unlike chatGPT,
  - do not drain environmental resources
  - do not pollute communities

- do not rely on unethical labor for training
- do not plagiarize the work of others
- do correctly cite their sources and additional reference material
- have been verified for accuracy by one or more mathematicians.

These alternative resources include my class notes and the textbooks listed above. **For these reasons I do not allow the use of ChatGPT or any similar AI model in this course.**

AI models have no guarantee of accuracy. Moreover, it is usually quite easy to identify when they have been used by students because the answers they generate involve mathematical concepts, language, or notation that haven't been taught yet. Using an AI model to 'think' for you will not help you learn the class material. **If you feel pressured to use an AI model like ChatGPT for any reason, please simply email me and ask for help instead.** I will always be more than happy to provide additional resources or meet with you to help.

The Faculty of Emory College are required to report suspected cases of academic integrity violations to the Dean of Student Affairs Office. If I suspect that you have cheated or plagiarized in this class, I must report the situation to the dean.

- **Student Accessibility:**

  Emory is committed advancing an accessible and barrier-free environment for students by ensuring that the principles of access, equity, inclusion, and learning are realized in and by the Emory community. If you have a documented disability and have anticipated barriers related to the format or requirements of this course, or presume having a disability (e.g. mental health, attention, learning, vision, hearing, physical or systemic), and are in need of accommodations for this semester, please assist me in accommodating you by registering with the Department of Accessibility Services.

  Students who have accommodations in place are encouraged to coordinate sometime with your professor, during the first week of the semester, to communicate your specific needs for the course as it relates to your approved accommodations. All discussions with DAS and faculty concerning the nature of your disability remain confidential.

- **Diversity and Inclusion:**

  Emory University strives to provide a welcoming, diverse, and inclusive campus as an essential part of a community of academic excellence. Dimensions of diversity include sex, race, age, national origin, ethnicity, gender identity and expression, intellectual and physical ability, sexual orientation, income, faith and non-faith perspectives, socio-economic class, political ideology, education, primary language, family status, military experience, cognitive style, and communication style. Please make a personal effort to respect and include all members of our community. See https://www.emory.edu/home/life/diversity.html for more information and resources.

- **Technology Services:** For assistance, please visit https://it.emory.edu/catalog/index.html

- **Office of Undergraduate Education (OUE):** The OUE provides a wide range of academic support for students, including academic advising, peer tutoring, and absentee policies (e.g., if you miss an exam).

- **Academic and Religious Holiday Calendar:** Please review the Academic Calendar for important dates about schedule changes and final exams. Please also review the Religious Holidays Calendar and communicate schedule conflicts with this course as soon as possible.

- **EPASS:** The course moves quickly and online learning can add additional challenges. Emory has an excellent peer-tutoring program that can be extremely helpful. Visit Learning and Peer Assistant Tutoring.

Required Technology

- **Canvas:** All course contents will be hosted on Canvas. This includes lecture notes, homework assignments, solutions, discussions, and more. All announcements will be done through Canvas. In addition, uploading work and grading will be done through Canvas. For information, visit https://canvas-support.emory.edu/
- **Zoom:** While lectures and office hours predominately will be held synchronously in person, there are unexpected time conflicts that might arise, so access to Zoom will be beneficial. Information about meeting rooms and passwords will be provided soon. For information, visit https://it.emory.edu/office365/ZOOM.html
- **CamScanner:** You will be required to upload written work in PDF form for the course. A good, intuitive, free app to do this is CamScanner. For information, visit https://www.camscanner.com/
- **Gradescope:** You will be required to upload written work in PDF form for the course. We will submit these assignments online via Gradescope. While Canvas does allow for submission of assignments, Gradescope is very helpful to allow quick, in-depth, and valuable feedback for you. The course can be found at https://www.gradescope.com/courses/1215501. Students can add themselves if you give them this entry code: *ZJYYYD*. You will also be added if you are currently enrolled in the class.
- **Google Colab:** Occasionally visualizations from class will be made available to students. These will be written as Jupyter Notebooks (math equations, text, and runnable code in the same document). These will be posted to Canvas and the course website. To actually interact with them, you will need a Google account so you can run Google Colab. For information, visit https://colab.research.google.com/
- **MATLAB:** Occasionally visualizations from class will be made available to students. These will be written as MATLAB LiveScripts, which are very similar to Jupyter Notebooks. These will be posted to Canvas and the course website. To actually interact with them, you will need either MATLAB installed on your personal machine or MATHWORKS Online. Emory has a license for all students. For information, visit www.mathworks.com/academia/tah-portal/emory-university-300274.html

Tentative Course Schedule

Note: This syllabus is a general plan for the course; deviations may be necessary.
This has last been modified on January 7, 2026.

Week	Dates	Sections	Content
Week 1	Jan. 14	Matrix Lecture Notes	Introductions; Syllabus; Matrix Review
Week 2	Jan. 19, Jan. 21	MLK, Jr. Day (no class), Matrix Lecture Notes GT §1	Single Person Decisions
Week 3	Jan. 26, Jan. 28	GT §2	Two Person Games **Homework 0: Matrix Math** (due Wednesday, Jan. 28)
Week 4	Feb. 2*, Feb. 4*	GT §3	Pure and Mixed Strategies; Nash Equilibria
Week 5	Feb. 9, Feb. 11	GT §4	Dynamic Games; Complete and Incomplete information **Homework 1: GT §1,2** (due Wednesday, Feb. 11)
Week 6	Feb. 16, Feb. 18	LP §1.1	Linear Programming Problem **Presentation 1: GT (Feb. 18)**
Week 7	Feb. 23, Feb. 25	LP §1.2, 1.3	Matrix form of Linear Programming; Solving LP via software, Introduce LP Project **Homework 2: GT §3,4** (due Wednesday, Feb. 25)
Week 8	Mar. 2, Mar. 4	LP §1.3, §1.4	Geometry of Linear Programming Problems; Extreme Point Theorem
Week	Mar. 9, Mar. 11		Spring Break (no class)
Week 9	Mar. 16, Mar. 18		In-Class Work Day **Homework 3: LP §1.1, 1.2** (due Wednesday, March 18)
Week 10	Mar. 23, Mar. 25	Midterm Review	**Presentation 2: LP (March 23)** Midterm Review
Week 11	Mar. 30, Apr. 1	SP §1.1	Definitions and Examples of Markov Chains **Homework 4: LP §1.3,1.4** (due Wednesday, Apr. 1) **Midterm Exam: GT and LP (Apr. 1)**
Week 12	Apr. 6, Apr. 8	SP §1.2, 1.3	Multistep Transitions; State Classification
Week 13	Apr. 13, Apr. 15	SP §1.4, 1.5	Stationary Distributions; Limit Behavior **Homework 5: SP §1.1,1.2,1.3** (due Wednesday, Apr. 15)
Week 14	Apr. 20, Apr. 22	SP §1.5, §1.6	Limit Behavior; Special Examples
Week 15	Apr. 27	SP §1.6	Catch-up Lecture **Homework 6: SP §1.4,1.5,1.6** (due Monday, Apr. 27)
Final Presentation: SP **Wednesday, May 6 (originally scheduled 11:30 A.M. - 2:00 P.M.)**			

**I am traveling for a conference. Classes will be recorded and posted to Canvas.*