ORI 397
Systems Modeling

Professor

Benjamin D. Leibowicz
bleibowicz@utexas.edu
ETC 5.128D

Course Description

Many of the most pressing policy challenges of our time transcend traditional disciplinary boundaries and necessitate the use of systems models to analyze possible solutions. This course will show how methodological approaches from operations research and industrial engineering can be applied to construct such models. Particular emphasis will be devoted to models that combine concepts from engineering, economics, natural sciences, and policy. The featured models will showcase a broad range of methodological approaches, such as optimization, simulation, dynamic programming, decision analysis, stochastic processes, and dynamical systems. Example applications will be drawn from fields including energy and climate change, health policy, transportation, and national security. More generally, the course will train students to build mathematical models that represent complex real-world problems.

Prerequisites

There are no formal prerequisites for this course other than a solid quantitative background and enthusiasm for mathematical modeling. That being said, the more prior coursework you've had in various methods, the more approaches you will be able to comfortably deploy as you build models. In particular, some background in economics and optimization would be useful. The first week of the semester will include a crash course in these subjects to serve as a review for some and an introduction for others. Knowledge of other methods, such as decision analysis, stochastic processes, and simulation, is potentially helpful but certainly not expected.

Lecture Time and Location

Lectures will be held on Tuesdays and Thursdays from 3:30 – 5:00 PM in ETC 7.146.

Office Hours

Office hours will be held on Tuesdays and Thursdays from 2:15 – 3:15 PM in ETC 5.128D. If you need to meet with me outside these office hours, please email me stating the specific problem or topic you wish to discuss.

Required Textbook

There is no required textbook. Readings will be provided via the course website and will consist mainly of scholarly articles from the academic literature.

Materials and Equipment

Part of the lecture time will be reserved for you to practice developing a model to represent and analyze some real-world problem. For this reason, you should come to class with a notebook, a scientific calculator, and probably a laptop. On some of the assignments you will likely want to implement your model as a computer program. The particular format you choose (e.g., Excel, MATLAB, AMPL, GAMS, etc.) is up to you.

Course Website
All course materials will be posted on *Canvas*.

Grading
Your final grade will be calculated using the following weights:

Modeling Assignments – 40%
Team Project Presentation – 15%
Team Project Report – 30%
Participation – 15%

Letter grades will be determined according to the following conversion:

A	93% or greater
A−	90% to <93%
B+	87% to <90%
B	83% to <87%
B−	80% to <83%
C+	77% to <80%
C	73% to <77%
C−	70% to <73%
D+	67% to <70%
D	63% to <67%
D−	60% to <63%
F	<60%

I may choose to raise your final grade by curving or some other method. However, these adjustments will never lower your grade.

Attendance and Participation
I will not take attendance or formally penalize you for missing a lecture. However, at the end of the semester, participation will count as 15% of your final grade in the course. Systems models are best developed through a team effort in which individuals with different skills and areas of expertise work together. Many of the application areas we will cover are simply too broad and interdisciplinary for any individual to tackle alone. The purpose of including participation in your final grade is to encourage you to exchange ideas with your fellow students and build better models through effective teamwork.

Modeling Assignments
A total of four modeling assignments will be given over the course of the semester. You are not allowed to work on these assignments in teams. You must complete them individually and submit your own write-ups. Each modeling assignment will provide a brief overview of some

real-world problem, and ask you to develop a model that enables you to analyze the problem and arrive at useful insights and solutions.

Your write-up should include the following elements and be approximately five pages in length:

1. **Issue Summary**
   Give a brief overview of the problem or issue you are modeling, and why it is important.
2. **Model**
   Provide a clear, formal, mathematical description of your model.
3. **Results**
   Show the results you are able to derive and generate using your model.
4. **Conclusions**
   Acknowledge the strengths and weaknesses of your model. Summarize what you have learned from it.

If you implement your model as a computer program, you may wish to include the code. However, the code will never be treated as a substitute for any of the write-up components listed above. For example, even if you include your code, you must still have a clear, formal, mathematical description of your model in the write-up. The grades you receive on the modeling assignments will reflect the appropriateness of your model for the problem at hand; the relevance and accuracy of your results; your ability to properly interpret the model and results; and the quality and clarity of your writing and presentation.

Team Project

A major part of the course is the team project. You will work on the project in teams of three or four students over the course of about a month. For the team project, you are free to choose the problem or issue you want to model and analyze (subject to my approval). Be creative, and have fun with it! At the end of the semester there will be two deliverables associated with the team project. First, you will present your project to the class in lecture. Second, you will submit a report as a team. This report should be structured similarly to the modeling assignment write-ups, but should be more extensive and include additional components such as a literature review and sensitivity analysis.

Honor Code

I expect everyone to follow the UT Honor Code, which states:

“The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.”

All suspected violations of the Honor Code will be referred to the Administration for adjudication.

Disability Statement

Students with disabilities who require special accommodations need to get a letter that documents the disability from the Services for Students with Disabilities area within the Division of Diversity and Community Engagement (contact information below). This letter should be presented to me at the beginning of the semester and necessary accommodations should be discussed at that time. Five business days before an exam the student should remind me of any testing accommodations that will be needed.

Services for Students with Disabilities
512-471-6259
ssd@austin.utexas.edu
http://diversity.utexas.edu/disability/

Feedback

I want all of you to have a top-notch learning experience and want to be the most effective instructor I can be. I introduced this course to UT last year, and it earned a 4.5 overall course rating the first time around. Moving forward, I intend to make it better each and every time I teach it. I would be happy to receive any feedback you might have throughout the semester, and promise to give careful consideration to any suggestions you provide. At the end of the term you will all be asked to fill out the standard College of Engineering evaluation form. I would greatly appreciate if you could complete this evaluation thoroughly. It serves as an important indication of my teaching ability and will allow me to improve this course for future students.

Tentative Course Schedule

The course schedule below is subject to change and will be updated as frequently as possible.

Lecture	Application Area	Topic	Items Assigned	Items Due
1	Introductory Material	Introduction to Modeling		
2	Introductory Material	Crash Course in Economics		
3	Introductory Material	Group Exercise: Subway Ticket Enforcement		
4	Ecological Systems	Predator-Prey Interactions	Modeling Assignment 1	
5	Natural Resource Management	Fossil Fuel Extraction		
6	Natural Resource Management	Forestry		
7	Health Policy	HIV Transmission		
8	Health Policy	Medical Tests		Modeling Assignment 1
9	Electricity	Capacity Planning	Modeling Assignment 2	
10	Electricity	Electricity Storage		
11	Energy and Climate Change	Climate Change Mitigation		
12	Energy and Climate Change	Carbon Capture and Storage		
13	Energy and Climate Change	Rebound Effects		Modeling Assignment 2
14	Energy and Climate Change	Geoengineering		

15	** NO LECTURE*	** NO LECTURE*		
16	Natural Disasters	Prevention, Preparedness, Response		
17	Transportation	Congestion Charges	Modeling Assignment 3	Team Project Proposal
18	Transportation	Shared Autonomous Vehicles		
19	Cities	Urban Form		
20	Cities	Open Space		
21	Technological Change	Technology Costs		Modeling Assignment 3
22	Technological Change	Technology Diffusion	Modeling Assignment 4	
23	National Security	Cargo Screening		
24	National Security	Nuclear Weapons		
25	Sports	Baseball		
26	Sports	Football		Modeling Assignment 4
27	Social Choice	Electoral Systems		
28	Wrap-Up	Course Themes and Final Tips		
29	Final Deliverables	Team Project Presentations		Team Project Presentations

30	Final Deliverables	Team Project Presentations		Team Project Presentations
31	Final Deliverables			Team Project Reports