EAS 597 Environmental Systems Analysis

Time 1:00-2:30 Tuesday and Thursday
Location 1046 Dana

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Course Description

This course takes a systems approach to decision-making, with particular emphasis on problems that have conflicting objectives such as economic and environmental concerns. Optimal solutions will be obtained mathematically using a variety of linear and non-linear techniques.

The purpose of this course is to train students on concrete and rigorous problem-solving tools that provide a mathematical basis for decision-making. By the end of the course, students will be able to define systems and their boundaries, optimize systems for a set of constraints and objectives, determine the sensitivity of decisions and optimal solutions based on changes in constraints, translate complex problems into mathematical frameworks, and define appropriate sets of solutions when there are multiple, competing objectives.

Example problems span natural resource management, traditional environmental engineering processes, and issues in green design and environmental policy. A Michigan Sustainability Case will be used as a course capstone to integrate major course concepts

Resources

There IS a textbook for this course, available free online:

- Chinneck, J.W. Practical Optimization: A Gentle Introduction
  http://www.sce.carleton.ca/faculty/chinneck/po.html

If you are looking for additional explanations and background, some of my examples are adapted from:

- Revelle, C.S.; Whitlatch, E. E.; Wright, J. R.; Civil and Environmental Systems Engineering (2nd ed.), Prentice Hall, 2006.
- Haith, D. A. Environmental Systems Optimization. John Wiley & Sons, New York, NY, 1982.

Assignments

Homework and other activities will be assigned regularly throughout the semester. Unless otherwise indicated, homework sets may be completed by groups no larger than three, with a single solution set handed in. Late homework will receive a 10% deduction if not turned in during class, and an additional 10% for every additional day overdue.

Any disputes regarding graded material *must be written*, and turned in with the original copy within one week after it is returned to you.

Assessment Criteria

Assignments	25%
Exams (2 takehome exams)	30%
Group Project	30%
Presentation	
Paper	
Michigan Sustainability Case	10%
Participation	5%

Attendance Policy & Academic Honesty

Attendance at regularly scheduled class meetings is expected, as well as regular participation in class sessions. *It is recommended that you bring a calculator or calculating device to each class period*. If you are unable to attend a class, please email me in advance. Students may leave 15 minutes after the start of class if the professor or substitute has not arrived. Academic honesty is expected. Any violation of University of Michigan policy as described in the Student Handbook will not be tolerated and may result in a failing grade. It is expected that all assignments will be completed without consulting previous solutions. It is the responsibility of the student to be familiar with the terms of the academic honesty expectations.

Tentative Course Outline (Subject to Change)

Unit 1: Systems Optimization

Week

9/3 Introduction
The Systems Approach:
Establishing Objectives, Decision Variables, and Constraints
Exploring Different Types and Scales of Systems
Reading: Chapter 2: Introduction to Linear Programming

9/10 Solving Basic Linear Systems Problems
Graphing Decision Space and Objective Functions
Tragedy of the Commons as an Optimization Problem
Intro to Microsoft Solver
Reading: Chapter 3: Towards the Simplex Method

9/17 Binding and Non-Binding Constraints
Slack and Surplus Variables
Basis and Non-Basis Variables
Reading: Chapter 4: The Mechanics of the Simplex Method (skim)

9/24 Discussion of solution algorithms
Problems with Many Decision Variables
Finding New Optimum under Changing Constraints
Reading: Chapter 5:Solving General Linear Problems
Reading: Chapter 6: Sensitivity Analysis

10/1 Objective Function Sensitivity
Non-linear problems
Reading: Chapter 16: Introduction to Non-Linear Programming

Unit 2: Decision Analysis

10/8 Multi-criteria Decision Analysis (MCDA)
Solutions Using Alternate Objectives
Defining non-inferior sets (Pareto optimality)
Reading: See Canvas

Exam #1 – Take Home

10/15 FALL BREAK; No class
10/17 NO CLASS – Take Home Exam #1

10/22 MCDA (con't)
Pareto optimality and tradeoff analysis
Trade-off Evaluation (Environmental, Economic, Social Criteria)
Weighting and Constraint Methods
Cost-Benefit Analysis
Utility Scoring
Reading: See CTools

10/29 MCDA (con't)
Analytical Hierarchy Process
Matrix Method for generating scores and weights
Reading: See CTools

11/5 Project Proposal Workgroups

11/12 Network Analysis and Dynamic Programming – Solving Multi-Stage/Multi-Decision Problems
Reading: Chapter 8: An Introduction to Networks
Reading: Chapter 15: Dynamic Programming

Exam #2

11/19 Transportation policy as a Multi-Criteria Problem
Michigan Sustainability Case. Designing our Transportation Future: A Retrospective Analysis of the Model T
Reading: Model T Michigan Sustainability Case

11/26 Transportation policy as a Multi-Criteria Problem
Reading: Model T Michigan Sustainability Case

11/28 THANKSGIVING

12/3 Group Final Project Presentations

12/10 Group Final Project Presentations