SYLLABUS

SEFS 540 / ESRM 490 B Optimization Techniques for Natural Resources

Spring 2017

Lectures: *Winkenwerder Hall 107, 4:50-5:50pm, MW*
Labs: *Mary Gates Hall 030, 1:30-2:50pm, Th*
Course Web Site: http://faculty.washington.edu/toths/course.shtml
5 Credits

Instructor: Sándor F. Tóth
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Email: toths@uw.edu; Instructor Profile: http://faculty.washington.edu/toths/
Instructor's office hours: 2:00-4:00pm, M, Bloedel Hall 358, or by appointment.

Instructor's office hours: 2:00 - 4:00pm W, or by appointment.
TA: Celine Pastore: Office hours from 3:15-5:15 pm on Wednesdays and 9-11 am on Thursdays in 360 Bloedel Hall; email: cpastore@uw.edu; phone: 206-543-0827

Course Summary: This is a 5-credit problem-oriented course where the instructor's research projects serve as vehicles for introducing advanced analytical decision tools that can aid natural resource management. We will focus on spatial optimization problems in conservation, ecosystem management, landscape-level forest planning, conflict resolution and invasive species management. The following mathematical techniques will be covered: linear-, integer- and multi-objective programming, stochastic and combinatorial optimization and Markovian decision processes. The emphasis will be on model building rather than on algorithmic concepts. The students will learn how to select the most appropriate tools for various situations, how to use them, and how to interpret the results that these tools provide. While the target audience of the course is primarily graduate students, undergraduate students, who are interested in applying quantitative skills to environmental problems and have strong background in linear algebra, are also welcome. Those with strong math or engineering training will learn how to approach and conceptualize complex problems in the area of natural resource management. Those with strong biological, ecological or social science backgrounds will learn how useful mathematical modeling can be in providing answers to some familiar but challenging environmental questions.

Prerequisites: MATH 308 or solid knowledge of linear algebra. Undergraduate students can enroll with the permission of the instructor.

Course objectives:

By the end of this course, students should be able to:
(1) Decide if it makes sense to use a spatial optimization technique to address a particular natural resource problem;
(2) Understand the pros and cons of the various techniques;
(3) Formulate mathematical programming models;
(4) Solve mathematical programs using commercial software;

(5) Interpret the solutions of mathematical programs; and
(6) Understand the basics of stochastic optimization and Markovian decision processes.

Student/Instructor Responsibilities:

Learning should be a cooperative venture between the students and the instructor and among the students of a class. The following lists are incomplete, but should help clarify our roles and responsibilities to each other. Feel free to give me your own additions or comments.

Both the Students and the Instructor:

1. Be prepared and on time for class.
2. Treat everyone in the class with respect.

Instructor:

1. Set clear expectations and provide motivation for students.
2. Select and prepare course materials, and make them readily available to students in a timely fashion.
3. Explain difficult concepts.
4. Guide discussions and labs.
5. Provide fair and prompt feedback and grading.
6. Give students opportunities to provide feedback on the course and listen to their comments and suggestions.

Students:

1. Study assigned readings before class.
2. Complete all assignments on time.
3. Attend and participate in class and labs.
4. Think for yourself and ask questions.
5. Contribute at least your share to group assignments.
6. Give thoughtful feedback to the instructor on how to improve the course

Textbook:

- My lecture notes will be posted on the course website prior to the lectures. In addition, chapters from Marc E. McDill's (MMD) *Forest Resources Management* (Unpublished) will be used for certain topics.

Books for reference:

I will list the relevant sections in the following books after each lecture as applicable:

- Joseph Buongiorno and J. Keith Gilles. *Decision Methods for Forest Resource Management.* Elsevier Science (USA), 2003.
- John Hof and Michael Bevers. *Spatial Optimization for Managed Ecosystems*. Columbia University Press. New York, 1998.
- H. Paul Williams. *Model Building in Mathematical Programming*. Fourth Edition. John Wiley and Sons Ltd. England, 1999.

Grading:

Assignment	Weights	Notes
Homework Assignments (6)	20%	Individual work
Lab Assignments (6)	20%	Individual work
Class Project (1)	30%	Individual work
Midterm Exam (May 4, 1:30-2:50pm, MGH 030) – (1)	30%	Open-notes

Note: The actual number of assignments might be lower but not higher.

Course Policies:

- Grading: Table 1 shows the grading scale for both undergraduate and graduate students. The scale is based on the University of Washington's grading system: http://www.washington.edu/students/gencat/front/Grading_Sys.html
- Missed Exams: The UW policies will be followed.
- Academic Integrity Statement: Please follow the UW' policies on cheating and plagiarism: http://www.washington.edu/students/handbook/conduct.html. For more information on the University's academic integrity policy, definitions and examples of academic misconduct, please refer to: http://depts.washington.edu/grading/issue1/honesty.htm
- Students with Disabilities: If you have a disability that requires special attention, please see me at my office and contact the University's Disability Resources for Students Office (448 Schmitz, (206) 543-8924, (TTY) 543-8925, uwdss@u.washington.edu.). The Disability Resources for Students has a web site at http://www.washington.edu/students/drs/.

Table 1.

UNDERGRADUATE		
A	4.00	98-100%
A	3.90	96-98%
A-	3.80	94-96%
A-	3.70	92-94%
A-	3.60	90-92%
A-	3.50	89-90%
B+	3.40	88-89%
B+	3.30	87-88%
B+	3.20	86-87%
B	3.10	85-86%
B	3.00	84-85%
B	2.90	83-84%
B-	2.80	82-83%
B-	2.70	81-82%
B-	2.60	80-81%
B-	2.50	79-80%
C+	2.40	78-79%
C+	2.30	77-78%
C+	2.20	76-77%
C	2.10	75-76%
C	2.00	74-75%
C	1.90	73-74%
C-	1.80	72-73%
C-	1.70	71-72%
C-	1.60	70-71%
C-	1.50	69-70%
D+	1.40	68-69%
D+	1.30	67-68%
D+	1.20	66-67%
D	1.10	65-66%
D	1.00	64-65%
D	0.90	63-64%
D-	0.80	62-63%
D-	0.70	60-62%
E	0.00	55-60%
E	0.00	50-55%
E	0.00	40-50%
E	0.00	30-40%
E	0.00	20-30%
E	0.00	10-20%
E	0.00	0-10%

GRADUATE		
A	4.00	98-100%
A	3.90	96-98%
A-	3.80	94-96%
A-	3.70	92-94%
A-	3.60	90-92%
A-	3.50	89-90%
B+	3.40	88-89%
B+	3.30	87-88%
B+	3.20	86-87%
B	3.10	85-86%
B	3.00	84-85%
B	2.90	83-84%
B-	2.80	82-83%
B-	2.70	81-82%
B-	2.60	80-81%
B-	2.50	79-80%
C+	2.40	78-79%
C+	2.30	77-78%
C+	2.20	76-77%
C	2.10	75-76%
C	2.00	74-75%
C	1.90	73-74%
C-	1.80	72-73%
C-	1.70	70-72%
E	0.00	68-70%
E	0.00	67-68%
E	0.00	66-67%
E	0.00	65-66%
E	0.00	64-65%
E	0.00	63-64%
E	0.00	62-63%
E	0.00	60-62%
E	0.00	55-60%
E	0.00	50-55%
E	0.00	40-50%
E	0.00	30-40%
E	0.00	20-30%
E	0.00	10-20%
E	0.00	0-10%

TENTATIVE COURSE OUTLINE (Table 2):

Week 1 *(3/27-3/30)*	What will this course be about? Models and model building fundamentals, optimization models
	Building **linear programming** models
	Lab1: Linear programming with Excel Solver
Week 2 *(4/3-4/6)*	Linear programming applications in natural resources
	Financial analysis
	Lab2: More Linear programming with Excel Solver
Week 3 *(4/10-4/13)*	Financial analysis cont.
	Forest harvest scheduling with linear programming
	Discussion session on discounting
Week 4 *(4/17-4/20)*	Forest harvest scheduling with linear programming cont.
	Modeling environmental objectives and sustainability
	Lab3: Using Visual Basic to build math programs
Week 5 *(4/24-4/27)*	**Integer programming** and combinatorial optimization
	Reserve design – optimal reserve selection models
	Lab4: Using Visual Basic to build math programs cont.
Week 6 *(5/1-5/4)*	Reserve design cont. – dynamic reserves
	Overview
	Midterm (MGH 030: May 4, 1:30-2:50pm)
Week 7 *(5/8-5/11)*	Spatially-explicit forest planning
	Modeling green-up/adjacency constraints
	Lab5: Using CPLEX to solve math programs
Week 8 *(5/15-5/18)*	Modeling contiguous old-forest patches
	Multi-objective programming
	Lab 6: Using CPLEX for multi-objective programming
Week 9 *(5/22-5/25)*	Multi-objective programming cont.
	Game theory – mechanism design
	Class projects
Week 10 *(5/31-6/1)*	**Stochastic optimization, Markovian decision processes**
	Dynamic programming
	Class projects