Spring 2014

Water Resources Systems Engineering - Cornell University

Patrick Reed

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CEE 6200 Water Resources Systems Engineering
Mon, Weds 8:40am-9:55am
368 Hollister Hall

INSTRUCTOR: Dr. Patrick Reed
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OFFICE HOURS: Mon & Tu 3:30-5pm

REQUIRED E-TEXTS (available on Blackboard):

Text 1 (T1): Loucks, D. P. and E. van Beek (2005). Water Resources Systems Planning and Management: An Introduction to Methods, Models, and Applications, United Nations Educational, Scientific and Cultural Organization.

Text 2 (T2): Soncini-Sessa, R., E. Weber and A. Castelletti (2007). Integrated and Participatory Water Resources Management - Theory Amsterdam, Elsevier.

SUGGESTED FURTHER READING:

Revelle, C. S., E. Whitlatch and J. Wright (2003). Civil and Environmental Systems Engineering. New Jersey, Prentice Hall. (on reserve in library)

Grayman, W., D. P. Loucks and L. Saito, Eds. (2012). Toward a Sustainable Water Future: Visions for 2050. Reston, VA, American Society of Civil Engineers. (available on Blackboard)

Cody, B. and N. Carter (2009). 35 Years of Water Policy: The 1973 National Water Commission and Present Challenges, U.S. Congressional Research Service**:** 1-73. (available on Blackboard)

Maas, A., M. Hufschmidt, R. Dorfman, H. Thomas, S. Marglin and G. Fair (1962). Design of Water-Resource Systems: New Techniques for Relating Economic Objectives, Engineering Analysis, and Governmental Planning**.** Cambridge, MA, Harvard University Press. (on reserve in library)

COURSE DESCRIPTION:

Growing concerns about how “change” (climate, land-use, population, etc.) will strain our water resources is motivating the need for the next generation of professionals that can innovate the planning and management of these systems. Course topics build on the legacy of research in the water resources systems area and seek to provide a new generation of planners with an enhanced ability to discover and negotiate the highly uncertain tradeoffs we face in balancing the water resources demands of the future. Students will be encouraged to explore what sustainable water management means given conflicting demands from renewable energy systems, ecosystem services, expanding populations, and climate change. Students will learn to develop and apply deterministic and stochastic optimization and simulation models for aiding in water-resources planning and management. This course covers river-basin modeling, including water allocation to multiple purposes, reservoir design and operation, irrigation planning and operation, hydropower-capacity development, flow augmentation, flood control and protection, and urban water supply portfolio management. Student projects will encourage a deeper exploration of topics and tools of interest.

OBJECTIVES:

At the end of the course, students will be able to:

(1) *Develop and apply deterministic and stochastic optimization and simulation models for aiding in water resources planning and management.*
(2) *Better understand the challenges and uncertainties associated with reservoir operation and design, capacity development, flood control, and urban water management.*
(3) *Have working knowledge of linear programming, dynamic programming, multiobjective optimization, and global sensitivity analysis within a water resources engineering context.*
(4) *Promote sustainability, adaptivity, and reliability in our water resources systems while acknowledging their evolving pressures.*

TOPICS COVERED:

- *Integrated Water Resources Planning*
- *Water Resources Systems Modeling*
- *Frameworks for Decision Support*
- *Methods for Evaluating Alternatives*
- *Optimization Methods (LP, DP, Heuristics)*
- *Dominance. Multiobjective decisions.*
- *Sensitivity analysis*
- *Uncertainty Analysis*
- *Monte Carlo simulation*
- *River basin planning*
- *Urban water supply*
- *Climate change*
- *Planning under Deep Uncertainty*

CLASS FORMAT:

Class periods will be a mixture of lecturing and group discussion. I will expect you to actively participate in each lecture. Your participation will require that you keep current with the course reading assignments and actively participate in group discussions. As the semester progresses, a portion of class periods will be dedicated for discussion of homework assignments, case studies, final projects, and your course-related research interests.

PREREQUISITES:

Students should have had an introduction to probability and statistics as well as CEE 3230 and CEE 5930 (or BEE 4750). The course is designed for seniors and graduate students. Students will be expected to have comfort in a programming language of their choice (C, JAVA, Fortran, Matlab, Python, etc).

COMPONENTS OF COURSE GRADE:

The course will require active in-class participation, assignments, student lead lecturing, and a project. The participation component of the course will be evaluated based on a student's interactivity during normal lectures as well as discussion periods. Homework, lectures, and projects will be used to provide students the opportunity to explore course concepts in more detail.

Assignments: all assignments require well written and highly organized solutions. Each assignment will provide specific guidance on the expectations for their written report.

Projects: the course projects will require original work on an application or concept from the class. The goal is develop feasible pilot studies and serve as if the work will be submitted to a peer reviewed conference. As part of this, students will be required to prepare a lecture related to their project topic/results.

All assignments and projects should be done individually.

GRADING:

Participation	15 %
Homework	50 %
Lecture	10 %
Final Project	25 %

Letter grades will be based on the weighted average specified above and assigned as follows:

- A+ = 97-100%
- A = 94-96%
- A- = 90-93%
- B+ = 87-89%
- B = 84-86%
- B- = 80-83%
- C+ = 76-79%
- C = 74-76%
- C- = 70-73%
- D+ = 67-69%
- D = 64-66%
- D- = 60-63%
- F < 60%

I reserve the right to adjust your grades. Your grade will only improve if adjustments are necessary. Feel free to contact me during office hours or by appointment if you have grade-related questions or concerns.

ACADEMIC STANDARDS

Each student is expected to abide by the Cornell University Code of Academic Integrity (cuinfo.cornell.edu/Academic/AIC.html). Work submitted by CEE 5970 students for academic credit must be a student's own. For homework assignments, students are encouraged to help one another to understand the material and to develop solution strategies; with that strategy, each student should work out their own solution. If students work together to develop a spreadsheet model or other tools, their homeworks should explicitly acknowledge such collaborations, and each student should provide their own interpretation of results generated.

TENTATIVE COURSE SCHEDULE (SPRING 2014)

WEEK/DATE	TOPIC	ASSIGNMENTS
1 /		
1 / Jan 22	Lec 1: Course Introduction-Water Systems Challenges	T1: 3-21, T2: 5-17
2 / Jan 27	Lec 2: Water Systems Analysis: History & Context	Handout A
2 / Jan 29	Lec 3: Continuity in Hydrosystems	T2: 138-152, Handout B
3 / Feb 3	Lec 4: River Basins—Planning Models	T1: 325-364
3 / Feb 5	Lec 5: Rainfall-Runoff Simulation Basics	T2: 152-160, Handout C **Assignment #1 Due**
4 / Feb 10	Lec 6: Routing Basics	Handout C
4 / Feb 12	Lec 7: Discussion on Model Diagnostics	Handout D
5 / Feb 17	FEB BREAK NO CLASS ☺	
5 / Feb 19	FEB BREAK NO CLASS ☺	
6 / Feb 24	Lec 8: Simulation & Optimization	T1: 59-71, 81-90
6 / Feb 26	Lec 9: Linear Programming—The Basics	T1: 113-119 **Assignment #2 Due**
7 / March 3	Lec 10: Linear Programming—Analysis & Examples	T1: 120-132
7 / March 5	Lec 11: Dynamic Programming—The Basics	T1: 90-97
8 / March 10	Lec 12: Dynamic Programming—Further Examples	T1: 97-112
8 / March 12	Lec 13: Discussion of Reviews on Operations & Hydroeconomics	Handout E
9 / March 17	Lec 14: Evolutionary Algorithms—The Basics	Handout F
9 / March 19	Lec 15: Evolutionary Algorithms—Multiple Objectives I	Handout F, Handout G **Assignment #3 Due (including Project Prospectus)**
10/March 24	Lec 16: Evolutionary Algorithms—Multiple Objectives II	Handout G
10/March 26	Lec 17: Discussion on Frontier Challenges	Handout H
11/March 31	SPRING BREAK ☺	
11/April 2	SPRING BREAK ☺	
12/April 7	Lec 18: Performance Criteria—Shaping Formulations	T1: 293-321
12/April 9	Lec 19: Uncertainty: The Basics	T1: 255-265
13/April 14	Lec 20: Sensitivity: The Basics	T1: 265-285
13/April 16	Lec 21: Discussion on Planning under Deep Uncertainty	Handout I **Assignment #4 Due**
14/April 21	Student Lecture(s)	
14/April 23	Student Lecture(s)	
15/April 28	Student Lecture(s)	
15/April 30	Student Lecture(s)	
16/May 5	Student Lecture(s)	
16/May 7	Student Lectures(s)	
PROJECTS DUE MAY 7		