2017

Optimization in Water Resources Engineering

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Oregon State University
School of Civil and Construction Engineering
CE 540 – OPTIMIZATION IN WATER RESOURCES ENGINEERING (SPRING 2017)
CRN: 57991, Sec: 003, Credits: 3

Monday, Wednesday, Friday | 0900-0950 HOURS |
ROOM KEAR 202

Instructor: Dr. Meghna Babbar-Sebens (211 Owen, 541-737-8536)
meghna@oregonstate.edu

Office Hours: By appointment

Credit Hours: 3
Lecture Hours: 3 per week
Lab/Recitation Hours: n/a

Course Prerequisites: Hydrology (CE 512/BEE 512)

Course Materials on Canvas: https://oregonstate.instructure.com/

Course Description:
This course provides an introduction to Optimization Techniques commonly used in design of complex water resources systems. At the end of the course, the students are expected to be able to:

- Understand and formulate design problems in water resources and environmental systems as optimization problems
- Understand basic concepts of different optimization techniques
- Apply existing optimization techniques to solve different types of design and planning and management problems
- Read, understand, and interpret scientific literature on optimization in water resources engineering field

Text: Class Notes and handouts, including following recommended additional materials:

- Hiller, F.S. and Lieberman, G.J. (2005) Introduction to Operations Research, The McGraw Hill Companies, Inc., New York.
- Loucks, D.P. and Eelco van Beek (2005). Water resources systems planning and management: An introduction to methods, models and applications, UNESCO.
- Haith, D.A. (1982). Environmental Systems Optimization, John Wiley and Sons, Inc.,
- Mays, L.W. and Tung, Y.K. (1992). Hydrosystems engineering and management., McGraw Hill, USA.

- Simonovic, S.P. (2009). Managing water resources: Methods and tools for a systems approach, UNESCO publishing, France.
- Winston, W.L. (1987). Operations Research: Applications and Algorithms, PWS Publishers, Boston, MA.

Required Supplies: None. Handouts will be provided on Canvas.

Examinations: No exams.

Grading Policy: Homeworks – 60%
Project – 25%
Project presentation – 15%

Homework Policy:
Homework will be assigned regularly and is due at the beginning of class on the specified due date. If you will be out of town, please make arrangements to have a friend or classmate turn in your homework for you, or turn it in early directly to me. Feel free to discuss your homework with your fellow students. However, you have to submit an individual homework and your submission should be an honest reflection of your effort and your grasp of the material.

Each assignment requires:
1. Your name on each page of stapled solutions
2. A legible and well-organized step-by-step presentation (in pencil) of the solutions (include problem diagrams). Some students prefer to type up solutions and that is fine.
3. Boxed answers presented with proper units (when applicable)

Solutions will be made available after your assignments have been collected

Class Project:
You will need to first identify a water resources problem (a research article, an existing book, or from your current research). Submit one paragraph on what problem would you like to work on in a "project proposal" to me by **April 21**. Your task will be to identify the system, decision variables, objective functions, and constraints relevant to your problem. Once you have formulated the optimization problem, please use an appropriate method to solve the problem via any available software (Matlab toolbox, online codes, etc.). A presentation of your work and results will be required as a deliverable on the last day of class. **There is no project report necessary for this class.**

Topics covered include:
1. **Introduction:** Applications, formulations, and classification of optimization problems in water resources engineering, Methods

of Calculus for Optimization

2. **Linear programming:** Graphical method, Simplex method, Duality in linear programming, Sensitivity analysis, other algorithms for solving LP problems
3. **Dynamic programming:** Sequential optimization, computational procedure, curse of dimensionality
4. **Multi-objective Optimization:** Weighting method, Constraint method
5. **Optimization under Uncertainty:** Chance Constraints
6. **Heuristic Optimization Techniques:** Genetic Algorithms

Tentative Course Outline:

Wk	M	Lecture/Topic	W	Lecture/Topic	F	Lecture/Topic
1	4/3	Introduction	4/5	Introduction	4/7	Introduction **HW 1**
2	4/10	Introduction **(V)**	4/12	Introduction	4/14	Introduction
3	4/17	Linear Programming	4/19	Linear Programming	4/21	Linear Programming **Project Proposals Due** **HW 1 due**
4	4/24	Linear Programming **(V)**	4/26	Linear Programming **(V)**	4/28	Linear Programming **(V)** **HW 2**
5	5/1	Linear Programming	5/3	Linear Programming	5/5	Linear Programming
6	5/8	Dynamic programming	5/10	Dynamic programming	5/12	Dynamic programming **HW 3** **HW 2 due**
7	5/15	Dynamic programming	5/17	Dynamic programming	5/19	Dynamic programming
8	5/22	**Work on Projects**	5/24	**Work on Projects**	5/26	Multi-objective Optimization **HW 4** **HW 3 due**
9	5/29	**Memorial Day Holiday**	5/31	Multi-objective Optimization	6/2	Chance Constraints
10	6/5	Chance Constraints	6/7	Genetic Algorithms	6/9	**Project Presentations** **HW 4 due by Friday, 6/9.**

Statement Regarding Students with Disabilities

"Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098.

DAS e-mail address is Disability.Services@oregonstate.edu.

Statement of Expectations for Student Conduct, i.e., cheating policies: http://oregonstate.edu/admin/stucon/achon.htm

Class Attendance: Attendance is mandatory. You are expected to attend every class and participate. If you are unable to attend for a good reason, notify the instructor before that class. If you do miss class, it is your responsibility to find out from another student what was covered and any administrative information presented.

Disruptive Behavior: While the university is a place where the free exchange of ideas allows for debate and disagreement, all classroom behavior and discourse should reflect the values of respect and civility. Behaviors that are disruptive to the learning environment will not be tolerated. OSU's policy on disruptive behavior may be found at: http://oregonstate.edu/admin/stucon/disruptivebehavior.htm