Course: ***CIV_ENV 304, Civil and Environmental Engineering Systems Analysis, Sp 2017***

Credits: 1 Unit credit; contact hours: 3 hrs. lecture

Instructor: Pablo L. Durango-Cohen

Text: Revelle, C.S., Whitlatch, E.E., and Wright, J.R. (2003); Civil and Environmental Systems Engineering, Second Edition; Prentice Hall.

Material: Handouts, previous exams, etc. posted on Northwestern's Course Management System (www.canvas.northwestern.edu)

Description: This course explores problems that arise in planning and managing civil and environmental engineering systems. The techniques introduced, often used in operations research and management sciences, provide a basis to develop descriptive and prescriptive models to evaluate strategies and to select between them.

Prerequisites: Multivariate Calculus (Math 234) and Probability (CivEnv 306) recommended.

Requirement: Mathematical Techniques and Sciences (MTS) elective; Basic Engineering (Systems Analysis) elective.

Statement of course objectives:

1) Develop of a "systems perspective" that is necessary for planning and managing large-scale, complex engineering systems/projects.
2) Gain experience formulating and solving quantitative models for a range of civil and environmental engineering systems problems that fall in the following categories:
    a. Financial evaluation and selection
        i. Use Rate of Return Analysis to establish viability and preference among projects
    b. Dynamic optimization under uncertainty
        i. Use Bayes Law and the Total Probability Theorem to assess the value of acquiring information
        ii. Use dynamic programming to formulate and solve shortest path, maintenance optimization, and resource allocation problems.
    c. Multi-variable, constrained optimization
        i. Set up, evaluate and interpret first and second order optimality conditions, including (constraint) shadow prices
        ii. Formulation and solution of linear programming problems with applications to resource allocation, transportation, and scheduling
3) Become proficient in the use of commercial software (Microsoft Excel) to solve engineering problems (financial evaluation and selection, multi-variable constrained optimization, and dynamic optimization under uncertainty)
4) Hone ability to work in teams and convey technical results effectively.

Course goals	Program outcome	Assm't via	Examples of assessment	Assessment	Proposed action
1	a	R	Avg. case study score	100% > 70%	none
2.a	e	H, E	Exam 1 score	46%>70 %	Spend additional time covering material
2.a.1	e	H,E	Exam 1 Question 2	71%>70%	Spend additional time covering material
2.b.i	e	H, E	Homework 4 score Exam 1 Question 3	67%>70% 64%>70%	Reinforce application of Bayes Law
2.b.ii	e	H, E	Homework 5 score Exam 2 Question 1	71%>70% 85%>70%	none
2.c.i	e	H, E	Exam 2 Question 2	82%>70%	none
2.c.ii	e	H, E	Homework 7 score Exam 2 Question 3	57%> 70% 68%>70%	Spend additional time covering material
3	e, k	H, R	Avg. case study score	100%>70%	none
4	g, h	R	Avg. organization/presentation score on case studies	100%>70%	none

- Examples: homework (H), exam (E), written report (R),
- For each example provided in, provide an assessment for the entire class performance. Summarize with % of
  students with grades higher than minimum passing % = Pass (Y).

Topics covered:

Topic	**Approximate Duration:**
Economic Evaluation of Projects Cash-flow evaluation Exact and Inexact Measures of worth Mortgage Loans, Stocks, Bonds, and Options Depreciation and Taxes	3 weeks
Review of Probability Expectation and Conditional Expectation Bayes Law and the Total Probability Theorem	1 week
Decision Analysis Decision Trees Dynamic Programming Resource Allocation and Replacement Problems	3 weeks
Mathematical Programming Review of Calculus (constrained optimization) Formulation of Linear Programs Graphical solution of linear programs Sensitivity Analysis	3 weeks

Assessment:

Homework: 20%
Two case studies: 20% each
Two in class exams: 20% each