CEE 3000: CIVIL ENGINEERING SYSTEMS

Fall 2007
Location: Mason 142
Time: T/TH: 1:35 – 2:55P
Credits: 3 hours

Instructor

Dr. Adjo Amekudzi
Office: SEB 229
Phone: 404-894-0404
Email: adjo.amekudzi@ce.gatech.edu
Office Hours: MW 1:30 – 3:00P and by appointment
URL: www.ce.gatech.edu/~aa103/

Co-Instructors

Dr. Michael Meyer
Office: SEB 330
Phone: 404-385-2246
Email: mike.meyer@ce.gatech.edu
Office Hours: By appointment
URL: www.ce.gatech.edu/~mm39/

Dr. Lisa Rosenstein
Office: SEB 325
Phone: 404-385-0347
Email: lisa.rosenstein@ce.gatech.edu
Office Hours: By appointment
URL:www.ce.gatech.edu/fac_staff/research_bio.php?active_id=lr3

Course Description

This course introduces students to a Sustainable Engineering (SE) approach for planning, design, implementation, operation and renewal of civil engineering systems. The concept of sustainability is introduced as the operating paradigm for making decisions over the lifecycle of civil engineered facilities. Sustainability is concerned with continued progress and development of human communities while ensuring preservation of the natural and human environment to enable such development to continue. The *systems approach* is introduced as essential for SE, in how problems are defined, how analysis tools are used to evaluate the performance of facilities and services, how benefits, costs and risks are incorporated into decision-making, how the natural environment and social equity are considered; how facilities are operated and maintained after implementation, and renewed at the end of their useful lives.

Course Evaluation

The course grade is based on performance in four (possibly five) areas. With a 90% average or higher at the end of the semester, you will be exempt from taking the final exam (with sufficient evidence from work on the project that an "A" is deserved in the course).

3 Quizzes	30%
5 Homework Assignments	25%
1 Project Report/Team Presentation	25%
2 Communications Assignments	10%
1 Final Exam	10%

Course Conduct

This Georgia Tech Honor Code is the standard of conduct for this course. The Honor Code is available at http://www.honor.gatech.edu/.

Course Organization
The course is organized into four modules as follows:

Module 1: Sustainable Engineering and the Systems Approach

What is sustainability? How is it defined for civil engineered systems? What issues today make such a paradigm necessary for civil and environmental engineers? What are the present limitations with sustainability as an operational framework? What is a system? What is the systems approach? How does it relate to Sustainable Engineering in planning, design, project implementation, operations and renewal of civil engineered systems? How do engineers plan for systems? How do they represent systems for performance analysis purposes? How can we mathematically evaluate system performance? How do we address the social and environmental impacts of systems? How do we systematically approach infrastructure renewal?

Module 2: Mathematical Tools and Systems Performance Analysis

What techniques can be used to analyze the technical performance of systems? Methods presented include optimization by calculus, linear programming, queuing theory, computer simulation, probability and statistics for addressing uncertainty. What are the strengths and limitations of these techniques in the sustainability paradigm?

Module 3: Economic Decision-Making Tools and Project Evaluation

How do engineers identify the "best" among competing alternatives? What techniques can be used for such comparisons, e.g., net present worth, benefit-cost ratios, internal rates of return? How do we consider non-monetary benefits and costs in our assessment? What types of assessments are conducted to capture environmental and social impacts? What types of mitigation strategies are used to manage environmental and social impacts? How do engineers make decisions on systems operations, maintenance and renewal once a facility has been constructed and service begins?

Module 4: Project Presentations

The final lecture periods will be used for project presentations. Project presentations are a critical component of your engineering communications education. Your attendance will contribute to your grade for the oral communications component of this course. You are expected to attend and participate in **all** presentations in order to obtain full credit for this module of the course. During the oral presentations, you can earn bonus points for thoughtful questions that demonstrate a thorough understanding of the course material.

Engineering Communication
An important objective of this course is to develop basic skills in Engineering Communication. Homework and project presentations are designed to provide opportunities for this development, and will be partially graded on the student's ability to communicate effectively. Dr. Lisa Rosenstein, the School of Civil and Environmental Engineering's expert in Engineering Communication, will participate in this course and should be viewed as an important resource in developing written, oral and visual presentations.

Library Information Skills
Another important objective of this course is to develop basic library information and research skills (manual and electronic). Again, the project is designed to develop and assess these skills. In particular, the quality, range and balance of information sources used in the project will be evaluated. Ms. Lisha Li, the Civil Engineering Librarian for the Institute, will participate in the course by presenting a workshop on the basics of Library Information and Research Skills and should be considered an important resource as you develop your written reports. She can be reached at lisha.li@library.gatech.edu or 404-385-7185.

Course Web
The course web pages are located at https://t-square.gatech.edu/portal. Course handouts, lecture notes, homework assignments, exam solutions and other resources will be posted on the web.

Course Outcomes
The School of Civil and Environmental Engineering has adopted a set of desired outcomes for the undergraduate education program. This course is designed to meet the following outcomes:

1) Understanding civil engineering solutions in a global, societal and environmental context, consistent with the principles of sustainable development

2) Solving engineering problems by applying fundamental knowledge of math, science and engineering

3) Identifying, formulating and solving civil engineering problems that meet specified performance, cost, time, safety and other quality needs and objectives

4) Working and communicating effectively both individually and within multidisciplinary teams

5) Obtaining a solid understanding of professional and ethical responsibility, and a recognition of the need for and ability to engage in life-long learning

6) Experiencing an academic environment that facilitates and encourages learning and retention

Course Objectives
Upon completion of this course, the student should be able to:

1) Explain how the concept of sustainability is fundamental in the planning, design, project implementation, operation and renewal of civil engineered facilities
2) Evaluate quantitatively the performance of civil engineering systems and discuss the strengths and limitations of such evaluations
3) Use engineering/economic decision making tools to identify the best economic project alternative and discuss the limitations of such tools for incorporating environmental and social impacts in lifecycle decision making for facilities
4) Discuss approaches for incorporating environmental and social equity considerations in the planning, design and operation of engineering projects
5) Apply performance analysis, economic decision making, environmental and social impact analysis tools in an integrated manner to comparatively assess the quality of different civil engineered facilities or competing alternatives
6) Discuss and apply various approaches to address risk in systems analysis, and
7) Demonstrate the basics of professional technical communications: written, oral and visual.

Policies on Homework and Exams
Please note that all assignments **must** be handed in on the due date. Only medical reasons will be considered for late assignments. Only in extreme cases will late homework will be accepted with a penalty. In addition, personal trips must be scheduled around exams as exams **will not** be rescheduled to accommodate early trips home or any other trips of a personal nature.

Course Reader
The course reader is a compilation of articles and book chapters on civil engineering systems and sustainability. The reader is required for the course and is available at the *Engineer's Bookstore* (748 Marietta Street). Additional material will be given out to supplement the reader.

Course Outline

Week	Class	Date	Topics	Assignments
1	1	Aug 21	Course overview; Introduction to sustainability: trends, definitions, measurement; Systems representation and analysis; Planning from a systems perspective; Performance-based planning; Context sensitive solutions, Asset Management; Environmental and Social Impact Assessment	Project description out
	2	Aug 23		
2	3	Aug 28		HW1 out
	4	Aug 30		
3	5	Sept 4	Mathematical models, Optimization by Calculus	HW1 due
	6	Sept 6		Library Workshop*
4	7	Sept 11	Engineering Communication I: Written	COM1 out
	8	**Sept 13**	**QUIZ #1**	HW2 out
5	9	Sept 18	Engineering Communication II: Visual	COM1 due/COM2 out
	10	Sept 20	Optimization by Linear and Integer programming; Queuing Analysis; Incorporating uncertainty in systems analysis; Intro to Engineering Economy: Time Value of Money, Present worth, Factor Tables, Inflation	Project Bibliography due
6	11	Sept 25		COM2 due
	12	Sept 27		HW2 due
7	13	Oct 2		
	14	Oct 4		HW3 out
8	15	Oct 9	**FALL BREAK**	
	16	Oct 11	Equivalent uniform annual worth, Effective Rates, Arithmetic Gradient	
9	17	Oct 16		HW3 due
		Oct 18		
10	18	Oct 23	**QUIZ #2**	
	19	Oct 25	Geometric Gradient, Project Evaluation: Net Present Worth, IRR, Benefit/Cost Analysis, IRR	HW4 out
11	20	Oct 30		HW4 due
	21	Nov 1		HW 5 out
12	22	Nov 6	Engineering Communication III: Oral	HW5 due
	23	Nov 8	Depreciation, Spreadsheet Financial Tools, MCDM Methods, Ethics	Draft Report due
13	24	Nov 13		
	25	**Nov 15**	**QUIZ #3**	
14	26	Nov 20	**TBA**	
		Nov 22	**SCHOOL HOLIDAY**	
15	27	Nov 27	**PROJECT PRESENTATIONS**	
	28	Nov 29		
16	29	Dec 4		
	30	Dec 6		Final Report due
17		**Dec 12**	**FINAL EXAM [11:30A -2:20P]**	

*Homer Rice Center, GT Library 1 West

DISCLAIMER:

The instructor reserves the right to amend this syllabus as necessary. Any changes will be announced in class.

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School of Civil & Environmental Engineering
Georgia Institute of Technology
Fall 2007

READING LIST

Module 1: A Sustainability Perspective

Introduction to Sustainability

1) George Musser. **The Climax of Humanity**, Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
2) Joel E. Cohen. **Human Population Grows Up**, Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
3) Jeffrey D. Sachs. **Can Extreme Poverty be Eliminated?** Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
4) Stuart L. Pimm and Clinton Jenkins. **Sustaining the Variety of Life**, Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
5) Amory Lovins. **More Profit with Less Carbon**, Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
6) Barry R. Bloom. **Public Health in Transition**, Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
7) Herman E. Daly. **Economics in a Full World**, Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
8) W. Wayt Gibbs. **How Should We Set Priorities**? Scientific American Special Issue: Crossroads for Planet Earth, September 2005.
9) Erla Zwingle. **Cities -- Challenges for Humanity**, National Geographic Magazine, November 2002.
10) Richard J. Kapka. **Megaprojects -- They are a Different Breed**, Public Roads, July/August 2004.
11) B. Blanchard and W. Fabrycky, **Introduction to Systems**, Chapter 1, Systems Analysis and Engineering," Prentice-Hall, 1998.
12) A. R. Pearce and J. A. Vanegas. **Defining Sustainability for Built Environment Systems: an Operational Framework**, International Journal of Environmental Technology and Management, Vol. 2, Nos. 1/2/3, 2002.

Systems Perspectives of Planning and Design/Systems Analysis

13) T, Jewell. **The Planning/Design Process**, Chapter 1, A Systems Approach to Civil Engineering Planning and Design, Harper and Row, 1986.
14) C. S. Revelle, E. E. Whitlatch, and J. R. Wright, **Explaining Systems Analysis**, Chapter 1, Civil and Environmental Systems Engineering, Prentice-Hall, 2004.
15) Gwendolyn Hallsmith, **Systems Thinking for Communities**, Chapter 4, The Key to Sustainable Cities, Meeting Human Needs, Transforming Community Systems, New Society Publishers, 2003.

Module 2: Mathematical model representation of Civil Engineering Systems, System Analysis Methods

16) J. Liebman. **Introduction to Optimization**, in Planning and Design of Civil Engineering Systems, University of Illinois, 1997.

17) C. S. Revelle, E. E. Whitlatch, and J. R. Wright, **Models in Civil and Environmental Engineering**, Chapter 1, Civil and Environmental Systems Engineering, Prentice-Hall, 2004.

18) C. S. Papacostas and P. D. Prevedouros, **Queuing and Simulation,** Chapter 14, Transportation Engineering and Planning, Prentice-Hall, 2001.

19) P. Ossenbruggen. **Decision Analysis**, Chapter 4, Systems Analysis for Civil Engineers, John Wiley and Sons, 1984.

Module 3: Decision-Making Tools, Engineering-Economic Analysis, Project Evaluation, Incorporating Environmental Criteria, Incorporating Sustainability Criteria

20) P. Erickson. **Overview of Environmental Impact Assessment**, Chapter 1, A Practical Guide to Environmental Impact Assessment, Academic Press, New York, 1994.

21) W. R. Hudson, R. Haas, and W. Uddin. **Framework for Infrastructure Management**, Chapter 2, Infrastructure Management, McGraw-Hill, 1997.