ISE 576 Industrial Ecology[1]

Instructors:

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COURSE DESCRIPTION

Approaches and tools to evaluate products, processes, and systems in their entire life-cycle, including: material flow analysis, Design for Environment, input-output analysis, life-cycle assessment, industrial symbiosis, and sustainable consumption.

COURSE MATERIAL

Textbook:

Socolow, R., Andrews, C., and Berkhout, F. (Editors) (2006). *Industrial Ecology and Global Change.* Cambridge University Press.

COURSE SCHEDULE

Week	Topics
1	• Syllabus, Class Requirements, Expectations, Team Selection • Introduction to Industrial Ecology
2	• Life-cycle systems thinking • Human impact on carbon and nitrogen cycles
3	• Industrial activity and metals • Materials and energy
4	• Product life-cycle management • Design For Environment (DFE)
5	• Material Flow Analysis (MFA) • Prioritizing impacts in industrial operations
6	• Waste/by-product minimizations
7	• Life-cycle analysis • SETAC (process) models
8	• Life-cycle analysis • Economic Input-Output models
9	• Environmental Impact Assessment • Cost-Benefit Analysis
10	• Environmental impacts in supply networks

[1] Students who violate University standards of academic integrity are subject to disciplinary sanctions, including failure in the course and suspension from the University. Please familiarize yourself with the Academic Integrity guidelines found in the current SCampus and other University documents. Also, any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me as early in the semester as possible.

	• Mid-Term Exam
11	• Policies for dematerialization
12	• Policies for clean technologies
13	• Development, environment, energy efficiency
14	• Term paper presentations • In-class work on term projects and term papers
15	• Term papers • Peer evaluations

Note 1: The readings are to be completed ***before*** the class sessions indicated. Other items may be assigned prior to each session.
Note 2: Any material, presentation and/or task assignments in this class may be revised to accommodate the content and the pace of the class learning process.

COURSE GRADING

Deliverables	***Grade Format***	***Grade Distribution***
Mid-term exam	individual	**30%**
Term Project	Team	**50%** (25% presentation, 25% final paper)
Peer Evaluations	Individual	**10%** (5% at the mid-semester and 10% for final)
Participation	Individual	**10%** (Subjective grading by the Instructor based on the individual's participation in case exercises, class discussions and interaction with TA/Instructor inside and outside class)

Student Notes:

- Participate in class discussions, contribute individual experiences when relevant to the topic so that others can benefit and learn.
- Take individual responsibility for completing assignments/term project activities and make arrangements for audiovisual equipment with the professor at least one week ahead of time. No late work will be accepted.
- Follow the USC Guidelines for student integrity/honesty and students with disability.

TEAM FORMATION

General Rules for Teams
The teams are formed during the first session. The team members will define the team's activities using the following procedure. The team leader will perform the negotiations between the team and the instructor. We follow the rules for a semi-autonomous team structure. This includes:

- Each member should evaluate the other members on a set of performance indicators. You should use the peer evaluation form provided (see a sample below).

- All team members will receive equal grades for the portion of the grade assigned by the instructor based on the team's final project paper and presentation. All team members must participate in the presentation in equal coordination.
- All activities internal to each team is assigned, performed and managed by the team members. The instructor will only intervene when one or more of the team members deviate from acceptable norms of team behavior.

Peer Evaluation
Each team member must evaluate the performance of other team members on the basis of 9 dimensions of team performance. Please circle an appropriate number or give an in-between number for each criterion. Use the digital dropbox for delivery on time.

Caution: If you fail to deliver your peer evaluation on time, a zero will be assigned to your own evaluation score.

Peer Evaluation Form

Print rater's name: (first, last) Date:

Team number and title of the project:

Use a number from 0 to 100 for each criterion.

	Criterion	Name	Name	Name	Name	Name
1	Willingness to volunteer					
2	Ability to communicate verbally					
3	Listening/attentiveness					
4	Preparation					
5	Ability to work towards consensus					
6	Courtesy, Tact, Sense of Humor					
7	Open-mindedness					
8	Ability to offer/accept constructive criticism					
9	Ability to facilitate group process.					
	Total Points					
	Final Score (Total Points/9)					

All peer evaluations in this class will be kept ***strictly confidential***. The mean sum value for each student will be entered into a spreadsheet for the final grade calculation (see the Grade Assignment section). Please be honest and truthful in your evaluations of other students. The students must resolve any personal differences, judgments and conflicts within the structure of the team. The team leader should play a constructive role in such a conflict resolution.

Note: All peer evaluations are due at the time indicated in the class schedule. Any late evaluation will be assigned a zero.

TERM PROJECT

Introduction

This project is designed to deepen the student's knowledge in the application of industrial ecology tools and techniques to emerging and distributed energy systems. The purpose of this project is to learn how to:

- Organize and structure a set of industrial ecology questions related to energy systems generation, distribution and use on a life-cycle basis.
- Demonstrate creativity and initiative to analyze the interactions among the complex system components and their aggregate impacts on the environment.

Team Design for the Project

After the team formations, each team leader meets with the instructor to select one of the subjects outlined in the class. A team leader will lead the negotiations and discussions with the instructor. After the instructor's approval, the team will develop a detailed problem statement and generates an outline for the first short presentation. The second presentation is scheduled at the end of the semester with a paper due date. Within each team, members will have an opportunity to evaluate each other's performance using a peer evaluation system (see the peer evaluation instructions). The instructor's evaluation is based on the article's presentation effectiveness and technical content of the term paper. The instructor's grade applies to all members equally.

Energy Technologies under Consideration

The objective of this project is to apply the concepts, tools and techniques from industrial ecology to energy systems generation, distribution and use. The technologies you may want to consider include (but not limited to): carbon sequestration, solar, wind, geothermal, bio-based, nuclear, clean coal/gas, and nanotechnologies. *We are particularly interested in projects that involve mix technologies and fuel sources.*

Suggested Research Approach

The following items are suggested for better organizing your research activities for this project:

- Select an alternative energy technology that you think might make the most economic sense, has the least environmental impacts, and does these in the shortest period of time.
- Research the literature on the various sources of fuels for this alternative technology. Then, draw a systems diagram showing the elements of the technology in a life-cycle framework.
- Clearly state the component of this system and the complexities of developing, generating, distributing and using the energy under the study.
- Learn about how the current energy system with the current fuel and production mix is being evaluated for its efficiency and for its environmental impacts. We will try to provide the basic models and data sets for this step in the class.
- Develop models of material and energy inputs and outputs for this system. Begin with simple models and increase their sophistication as you search for new data for each component.
- Define the system scope and boundary.
- Decide on which industrial ecology tools and techniques you wish to use to analyze this system.
- Develop data models in Excel or any other software you choose to analyze your data.
- Collect as much data available in open literature, industrial contacts, government web sites, etc. Make sure that you state (as footnotes in your tables) the sources of the data used.
- Reduce and integrate your data for a meaningful description of the results.
- Compare your data with the current system in operation.
- Conclude and recommend what is found and what needs to be done in the future.

In addition, you should include the following:

- A list of hard copy and electronic references that you used for this project, including all the data sources and contact information.
- The final product is a paper documenting all the findings in this project.
- A set of completed peer evaluation forms will be required at the end of the presentation for this Term Project.

Organization of the Paper: Use the following outline, which is followed by most Industrial Engineering related publications:

1. Title (cover) page
2. Abstract followed by a set of 10 keywords for indexing
3. Body of the paper
    a. defining and motivating the problem
    b. identifying key technologies for the project
    c. describing the problem in a life-cycle framework
    d. identifying the key methodology for analyzing the system
    e. data analysis
    f. data quality, missing data, data gaps, etc.
    g. software applications, if any
    h. results in both descriptions and tabular forms
    i. conclusions

    j. future research needs
4. References (completely spell out names of journals and books with titles and dates)
5. Tables must be numbered with descriptive titles
6. List of Figures (with numbers and captions)
7. Figures preferably drawn in MSWord
8. Submit the entire file in MSWord

Each student in the team will define and present his/her own role in developing the specific portions of the article at the two article presentations (see the Schedule):

Article length should be less than 20 single-spaced pages, ***excluding*** figures and tables. Other material closely relevant to the topic should be placed in appendix (the appendix does not count in the page requirements). Like all other materials that you deliver to the instructor, it should list the team number, team members, a title, and date of delivery (on the cover page). Use digital drop box for delivery.