Course Syllabus

WEN502 – Systems Perspectives on Industrial Ecology

Water and Environmental Engineering Program

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1 Overview

1.1 Overview

Engineers can fundamentally change the environmental footprint of modernity. To effect change, engineers require tools to identify "better" design and operational options. This course examines the use of life-cycle thinking and assessment tools to identify product and system design options that balance environmental and economic performance. While this is very relevant, as a core course, to Water and Environmental Engineering students, it is also very helpful to students from other disciplines.

1.2 Learning Outcomes and Assessment Methods

1.2.1 Learning Outcomes

1. Understand the concept of industrial ecology and its relation to the impacts of industrial processes on the environment.
2. Understand the various stages of a life-cycle assessment (LCA) (e.g., scope definition, inventory analysis, etc) and their relevance to environmental evaluation process.
3. Proficiency with life-cycle thinking and life-cycle assessment methods.
4. Ability to conceive and compare processes, systems, or products in terms of their environmental products using LCA tools.
5. Ability to work in project teams and to communicate project results effectively and professionally in written and oral forms

1.2.2 Assessment Methods

There are no traditional "exams" in this course. Assessment is done through homework assignments (mini-projects) and three main projects. Specifically, the assessments methods include:

1. Written assignment on definitions of industrial ecology and application to particular products and/or industries.
2. Assignment on life-cycle inventory for a product using SimaPro software and inventory databases.
3. Case study (presentation and report) of the life-cycle impacts of a manufactured product and recommendations for product improvement.

1.3 Course Resources

1.3.1 Course Readings

Because the course covers a broad range of topics, there is no single comprehensive textbook. However, copies of the key reference: "The Hitchhiker's Guide to LCA – An orientation in Life Cycle Assessment Methodology and Application" is made available to all students to check-out of library as one main source on LCA. Thus, for course readings, students will be expected to consult:

- The book: "The Hitchhiker's Guide to LCA – An orientation in Life Cycle Assessment Methodology and Application";
- Reading materials, which will be provided on the course web site;
- Lecture slides for the course, which will be provided on the course web site.

A reading list is provided at the end of the syllabus.

1.4 Computing Environment

1.4.1 Course Management

A course management website will be used for overall management on the course. The web site is on Masdar Institute's *Moodle* system.

This web site is the primary means of distributing basic information about the course:

- Syllabus and Schedules of classes and the readings and assignments;
- Copies of Lecture Slides used in the lectures.

NOTE: Participants are expected to use email regularly to keep up with messages about the course from instructors. Messages sent by email will be considered to have been available to everyone.

1.4.2 Course Software

The case study projects for the course will rely heavily on *SimaPro*, a Life Cycle Analysis software commonly used among LCA professionals. Assignments will be given that cover tutorials and an introduction to the software.

1.5 Grading Policy

Grades will be based on various assignments throughout the term. Their weights are:

- HW Assignments: 30%
- LCA project 1: 10%
- LCA project 2 (Oral presentation, no report): 20%
- LCA project 3:
  - Oral presentation 10%
  - Final Report 20%
- Class Participation 10%

The final grade will be modulated by an appreciation of the participant's progress throughout the semester, giving extra weight to those that finish strongly and demonstrate that they have mastered the material, in the end.

Since the grading in this course will be mostly done based on homework assignments and course projects, it is very important that the students be informed of the criteria applied when grading each of these assignment types. They are as follows:

Homeworks: the main criteria for HW grading are:

- Analytical and critical comprehension and presentation of information
- Relevance of presented information
- Accuracy of calculations (for HWs involving calculations)
- Completeness and accuracy of provided answers
- Validity and justification of assumptions, when made.
- Thoroughness in searching the information (but without exceeding page limits)
- Reflection of good understanding and application of course concepts taught in the HW assignment

Projects: the main criteria for project grading are:

- Originality in the selection of the alternatives for the comparative LCA
- Creativity and depth in developing change scenarios for LCA comparisons (project 3)
- Inclusion of essential LCA elements (Functional unit, scope,

- Clarity of system description (including system boundaries)
- Thoroughness of inventory analysis
- Legitimacy of assumptions and their justification
- Quality and depth of results discussion (especially for impact assessment)
- Final recommendations (logic, clarity, support within study)
- Discussion of study limitations
- Data presentation (clarity, effectiveness, etc)
- Report formatting (including citations, language, effective utilization of page limit, etc)
- handling questions (during oral project presentations)

1.5.1 Absences

Students are expected to complete all assignments on time. Unexcused late assignments will be marked down. Reasonable excuses (sickness, unavoidable professional absences, family emergencies, etc.) will of course be accepted when presented near the event.

1.5.2 Work in Teams

Students will work in teams for the unit projects and some homeworks. Indeed, we encourage this collaboration because it can lead to more interesting results. However, the team members bear the responsibility of coordinating their workload and resolving any group-work-related issues.

1.5.3 Academic Honesty:

Most assignments turned in for grading are to be done individually, although it is expected that students will discuss the issues involved in problem sets and often learn best collectively. In practice this means that students may lead each other to the proper understanding of the material, and collaborate on setting up computer runs, but should ultimately prepare reports for each assignment individually, in their own format and words. Demonstrated evidence of copying (exactly the same wording of sentences, etc.) will result in zeros for each paper with this evidence.

1.6 Class Schedule Spring 2013

Class	Date	Day	Topic	Homework assigned	Homework Due	Readings Due
1	21/1	Monday	Course Introduction			
	24/1	Thursday	No class. Prophet's Birthday			
2	28/1	Monday	Why Industrial Ecology?- Role of Engineers			Frosch & Gallopoulos, 1989; Frosch, 1992; Graedel, 1996;
3	31/1	Thursday	What is Industrial Ecology?(pt 1): Definitions and Relation to Sustainability			
4	4/2	Monday	What is Industrial Ecology?(pt 2): Industrial Ecoparks and Other Examples	HW 1		Tillman – Ch1; Ehrenfeld & Gertler, 1997.
5	7/2	Thursday	Movie: An Inconvenient truth			
6	11/2	Monday	Environmental Evaluation - An Overview	HW 2	HW 1	Tillman – Ch3
7	14/2	Thursday	Life Cycle Assessment – Goal and Scope	HW 3		
8	18/2	Monday	Life Cycle Assessment – Inventory Concepts	**Projects introduced**	HW 2	

9	21/2	Thursday	Life Cycle Assessment – Inventory Allocation	HW 4	HW 3	Tillman – Ch4, Ekvall, 2000; Fennveden, 1999; Newell and Field, 1998; Weidema, 2000
10	25/2	Monday	Environmental Paradigms			Colby, 1990; Thompson, 1997, 2000; Janssen and Rotmans, 1994;
11	28/2	Thursday	Intro to Impact Assessment			Tillman – Ch5; Bengtsson & Steen, 2000.
12	4/3	Monday	Life Cycle Assessment – Impact assessment – EPS and EcoIndicator	HW 5	HW 4	Murray & Lopez, 1994.
13	7/3	Thursday	SimaPro workshop 1			
14	11/3	Monday	SimaPro workshop 2			
15	14/3	Thursday	LCA case study 1-TBD		HW 5	
16	18/3	Monday	LCA case study 2-TBD			
17	21/3	Thursday	LCA project 1 presentations-		Student Presentations	
18	25/3	Monday	LCA project 1 presentations- Continued		Student Presentations	
19	28/3	Thursday	LCA project 2 Workshop			
	1/4	Monday	No class. Mid-semester break			
	4/4	Thursday	No class. Mid-semester break			
	8/4	Monday	No class. Mid-semester break			
	11/4	Thursday	No class. Mid-semester break			
20	15/4	Monday	LCA project 2 presentations-		Student Presentations	
21	18/4	Thursday	LCA project 2 presentations- Continued		Student Presentations	
22	22/4	Monday	Movie: The Blue wars			
23	25/4	Thursday	Materials Flow Analysis	HW 6		Bouman, 2000
24	29/4	Monday	Materials Flow Analysis presentations		HW 6-Student Presentations	
25	2/5	Thursday	The Water footprint			
26	6/5	Monday	LCA project 3 presentations-		Student Presentations	
27	9/5	Thursday	LCA project 3 presentations- Continued		Student Presentations	
	13/5	Monday	No class. Final exams week			
	16/5	Thursday	No class. Final exams week			

1.7 Other logistics

1.7.1 Class time/location

Monday-Thursday, Classroom 4, 2:45-4:00 PM

1.7.2 Office hours:

Due to the dynamic nature of the work at Masdar Institute (meetings, research activities, etc), setting office hours that cannot be broken may be difficult. So, the students are welcome to stop by the Dr. Arafat's office at any time for questions, etc. If the student prefers to setup an appointment beforehand with Dr. Arafat, that would also be fine.

1.7.3 Teaching Assistants:

This course has two teaching assistants, Tariq Al-Sarkal (talsarkal@masdar.ac.ae) and Sanaa Pirani (spirani@masdar.ac.ae). Tariq will be in charge of handling issues related to the SimaPro software (training, student questions), while Sanaa will help with homework grading. Project and participation grading as well as final grade determination rests entirely with Dr. Arafat.

1.8 Reading List

Robert U. Ayres and Leslie Ayres, *A handbook of industrial ecology* (Edward Elgar Publishing, 2002).

Robert U. Ayres and Udo Ernst Simonis, *Industrial metabolism* (United Nations University Press, 1994).

R. U Ayres et al., "Is the US economy dematerializing? Main indicators and drivers," *Economics of Industrial Ecology. Materials, Structural Change, and Spatial Scales. MIT Press, Cambridge, MA* (2004).

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1.9 Acknowledgements

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