ME 4171 Environmentally Conscious Design and Manufacturing (Elective)

Catalog Description: ME 4171 Environmentally Conscious Design and Manufacturing (3-0-3)

Prerequisites: Senior standing

Including environmental considerations in engineering design; reducing environmental impact by design; recycling; material selection; de- and remanufacturing; life-cycle considerations, analyses, trade-offs; ISO 14000.

Textbook: Course notes, handouts, and reading material used in this class will be provided by instructor. Various reading materials are located on the class website. These include selected chapters from:

Green Products by Design: Choices for a Cleaner Environment, US Congress, Office of Technology Assessment, OTA-E-541, US Government Printing Office, Washington, D.C., October 1992.

Environmentally Benign Manufacturing, International Technology Research Institute, World Technology (WTEC) Division, Panel Report, April 2001.

Both can be downloaded from the course website.

Topics Covered:

1. Environmental impact of engineering products and processes
2. Sustainable development
3. Business drivers: legislation, risk, image, etc.
4. Life-cycle analysis (LCA)
5. Pollution prevention
6. ISO 14000 Environmental management standards
7. Life-cycle design, cradle to gate, cradle to grave, cradle to cradle
8. Use phase impacts and user behavior
9. Design for recycling
10. Service, reuse, and remanufacturing
11. Life-cycle costing, externalities, ecological services
12. Biologically inspired design

Course Outcomes:

Outcome 1: To teach mechanical engineering students and others interested in engineering design how the environmental impact of engineering systems can be reduced by design.

1.1 Students will demonstrate the ability to reduce the environmental impact of engineering systems by providing viable options for the redesign of specific products and processes and demonstrating the reduction of environmental impact in a scientific manner. The documentation and completeness of the design process followed and results obtained are indicators of performance.

1.2 The students will demonstrate:

- that they understand the motivation, terminology, and issues involved
- the ability to recommend viable pollution prevention options in a manufacturing and/or shop floor environment
- the ability to correctly assess and improve a product's recyclability and remanufacturability
- the ability to perform a life-cycle assessment and correctly interpret and utilize the results
- the ability to perform/document a product (re)design which takes all life-cycle considerations into account

- that they can reason about how to implement an ISO 14000 compliant environmental management standard in a specific business practice
- that they can identify the issues involved in achieving sustainable development.

Outcome 2: To illustrate to students the multi-disciplinary and multi-dimensional aspects of environmental issues, as well as the rapid development of the approaches and tools to reduce the environmental impact of engineering systems, and emphasize the need to keep learning.

2.1 Students will demonstrate the ability to seek and learn new material outside the class topics through the completion of an open-ended homework, report, term paper, computer assignment, and/or project. The amount as well as depth of new material identified and used by the students are measurable indicators of the students' performance.

2.2 Student will demonstrate the ability to make proper assumptions, synthesize material from different subject areas, in particular from environmental engineering, public policy, management, and mechanical engineering disciplines.

Outcome 3: To teach students how to identify and quantify the environmental issues and perform design selection and trade-off decisions which include environmental issues.

3.1 Students will demonstrate the ability to take environmental health and safety, waste minimization, energy consumption, natural resource depletion, and other environmental issues (e.g., as identified by the Environmental Protection Agency) into account when assessing and redesigning a product. The breadth and depth of the issues taken into account by students are measurable indicators of their performance.

3.2 Specific issues to be quantified are process waste and mass balance, product recyclability, product remanufacturability, and product life-cycle assessment, in correspondence to the topical areas and course outcome 1.2. The correctness of the quantification is a measurable indicator of the students' performance.

Outcome 4: To teach students how to apply specific guidelines, methods, techniques, and (computer-based) tools in reducing the environmental impact of engineering systems.

4.1 Students will demonstrate their ability to use existing (computer-based) methods, techniques, and tools for environmental assessment and improvement, in particular methods and tools focused on assessing and improving a) specific life-cycle and/or environmental aspects (e.g., recyclability, remanufacturability), and b) the total life-cycle impact (e.g., LCA tools). The maturity, completeness, and efficiency of their approach are indicators for their performance.

Correlation between Course Outcomes and Student Outcomes:

ME 4171											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1			X		X		X	X		X	
Course Outcome 1.2	X	X		X				X		X	X
Course Outcome 2.1				X			X	X	X	X	
Course Outcome 2.2				X	X	X		X	X		X
Course Outcome 3.1					X	X		X		X	
Course Outcome 3.2	X				X			X			X
Course Outcome 4.1	X	X			X						X

GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Prepared by: Bert Bras