Appendix D. Course Syllabi

37. Introduction to Sustainable Engineering

Carnegie Mellon University

SUMMARY

Offered by: Civil and Environmental Engineering
Instructor(s): Cliff Davidson and Scott Matthews

Number of times taught: Three or More
Class size: 10 to 30
Class format: 3 hours of lecture per week

Portion of course focused on sustainable engineering: More than 50%

Student Level: Graduate and upper division (4:1)
Students' Major: 50% Civil and Environmental Engineering
40% Other engineering
10% Non engineering

INTRODUCTION TO SUSTAINABLE ENGINEERING

12-712

Cross listed as 19-622
Course Syllabus
Fall 2007 First Mini, 6 units

Cliff Davidson
Professor of Civil and Environmental Engineering/ Engineering and Public Policy

August 27, 2007

Carnegie Mellon University **Dept. of Civil & Environmental Eng.**
CEE 12-712 Fall 2007, First Mini **Instructor: Cliff Davidson**

INTRODUCTION TO SUSTAINABLE ENGINEERING

Course meets on Monday and Wednesday, 3:00-4:20 in Porter Hall 7F
Instructor: Cliff Davidson, PH 123E, ext. 8-2951, e-mail: cliff@cmu.edu
Teaching Assistant: Shahzeen Attari, PH A2, ext. 8-6826, e-mail: sza@andrew.cmu.edu

The teaching assistant will establish office hours to help students who have questions about the course material. Students are also encouraged to contact Cliff Davidson, the course instructor, if there are questions about the course material or if any other questions or problems arise.

References: There is no textbook for this course. However, the class will use summaries of journal articles as well as summaries of books provided by the instructor. Some of the books from which material has been taken include the following:

Florman, Samuel C., *The Existential Pleasures of Engineering*, St. Martin's Press, New York, NY, 1976.

Lomborg, Bjorn, *The Skeptical Environmentalist: Measuring the Real State of the World*, Cambridge University Press, Cambridge, England, 2001.

Meadows, Donella H., Dennis L. Meadows, Jorgen Randers, and William Behrens III, *The Limits to Growth*, Universe Books, New York, NY, 1972.

Orr, David W., *Ecological Literacy: Education and the Transition to a Postmodern World*, State University of New York Press, Albany, NY, 1992.

Schmidheiny, Stephan and the Business Council on Sustainable Development, *Changing Course: A Global Business Perspective on Development and the Environment*, MIT Press, Cambridge, MA, 1992.

Simon, J.L., *The Ultimate Resource 2*, Princeton University Press, Princeton, NJ, 1996.

World Commission on Environment and Development, *Our Common Future*, Oxford University Press, Oxford, England, 1987.

Course Objective:

The student successfully completing this course will have a solid understanding of the emerging discipline of sustainable engineering. The student will be able to list the historical factors that led to the birth of this discipline, list the most important fundamental principles behind it, and discuss alternative viewpoints about the discipline by several authors. He or she will also be able to solve several types of problems estimating the human impact on global systems.

Course Structure:

Homework assignments are due at the beginning of class. Late homework assignments will have scores reduced by 10% for each 24-hour period following the beginning of class on the due date. Homework assignments received after the graded papers are returned cannot receive credit but may be turned in for grading to obtain feedback.

If you are absent from class, it is your responsibility to obtain copies of the material and any assigned work. If you are dissatisfied with the grade you have received on any material for this course, you should initiate discussion with the teaching assistant within one week after receiving the graded material. The teaching assistant will then discuss the issue with the course instructor. Changes of grade will be granted only in exceptional circumstances, such as a math error in totaling points or work that was overlooked by the grader.

You are allowed to discuss homework problems with your classmates, but all written work must be individual efforts. Copying of assignments is not allowed; any evidence of cheating or plagiarism will be dealt with according to university policies.

Grade Allocation:

Class Participation	10%
Homework	40%
Research Report	15%
Final Exam	35%

Note that each student is required to complete a short research report on a topic of his or her choosing related to sustainability. Details of what is expected in the report will be given in class.

Tentative Course Outline:

1. UNIT 1: Introduction: The Concept of Environmental Sustainability
   a. Examples of non-sustainability and sustainability
   b. The special role of engineers in helping society transition to a more sustainable state

2. UNIT 1: Introduction: Definitions, Principles, and Indicators of Sustainability
   a. Examples of different definitions and principles
   b. Overall criteria for development that is sustainable
   c. Indicator studies

3. UNIT 2: The Rise of Sustainability: Philosophical debates
   a. Historical perspectives in Europe (Industrial Revolution) and in the U.S., (Development during the 1600's-1800's)
   b. Modern debates: (1) Sustainability extremists, (2) Environmentalists, (3) Traditional engineers, and (4) Anti-sustainability extremists
   c. "Tragedy of the Commons" and the ethics of sustainability

4. UNIT 2: The Rise of Sustainability: Political and Business Perspectives
    a. Club of Rome: *Limits to Growth*, 1972, model of population, industrial output, food production, resources, and pollutants
    b. World Commission on Environment and Development, a.k.a. Bruntland Commission: *Our Common Future*, 1987, balancing economic growth and environmental preservation
    c. Business Council on Sustainable Development: *Changing Course*, 1992, business strategies for sustainability
    d. Models for achieving sustainable industries: role of innovation in making the leap

5. UNIT 2: The Rise of Sustainability: UN Conferences
    a. First two UN Conferences on Environment and Development (UNCED) in Stockholm (1972) and Rio de Janeiro (1992)
    b. Third UNCED in Johannesburg (2002) and the Millennium Development Goals

6. UNIT 3: Population Growth on a Finite Earth: Population Models
    a. Thomas Malthus and exponential growth
    b. Logistic population model, carrying capacity

7. UNIT 3: Population Growth on a Finite Earth: Food Production
    a. Trends in arable land availability
    b. Land needed for food production per capita

8. UNIT 3: Population Growth on a Finite Earth: Water Resources
    a. Three main categories: water withdrawn from runoff, in-stream water, and water evapotranspirated from vegetation
    b. Amounts of fresh water available for (1) human needs, and (2) ecosystems

9. UNIT 3: Population Growth on a Finite Earth: Urban Sprawl
    a. Urbanization as a global phenomenon
    b. Characteristics of sprawl: low-density development; segregation of land use by activity; dominance of personal mobility by cars; unlimited outward expansion
    c. The continuum between "sprawl" and "non-sprawl"
    d. Environmental effects of sprawl

10. UNIT 4: Non-Renewable Resources: Fossil fuels
    a. Formation of fossil fuels: oil, natural gas, coal
    b. Modeling of oil reserves: Hubbert's curve

11. UNIT 4: Non-Renewable Resources: Metals
    a. Material Flow Analysis
    b. Environmental effects of mining and processing metals
    c. Time-to-depletion

12. COURSE SUMMARY

38. Introduction to Sustainable Engineering

University of New Hampshire

SUMMARY

Offered by: Civil Engineering
Instructor(s): Kevin Gardner

Number of times taught: Twice
Class size: 10 to 30
Class format: 3 hours of lecture per week

Portion of course focused on sustainable engineering: More than 50%

Student Level: Upper division and graduate (1:1)
Students' Major: ≥90% Civil Engineering

Course Syllabus
ENE 751 / CiE 851 Introduction to Sustainable Engineering
3 credits, elective
Instructor: Kevin Gardner
(Prepared by Kevin H. Gardner, PE, PhD, Associate Professor, 29 November 2007)

Text: no text book for this class. Readings will be assigned from the literature and posted on Blackboard.

Course Description
This course begins with exploration of the precept that we live in, and must design engineering systems for, a world with a finite supply of natural resources and an earth with limited life support capacity. The course will cover aspects of life cycle analysis, green building design and architecture, energy systems and alternative energy, pollution prevention / green chemistry principles, design for the environment, environmental management systems, and ISO 14001 implementation. Tools for sustainability engineering will be the major focus of the course, which include life cycle analysis and life cycle impact analysis, the metrics and mass and energy flow analyses used in the field of industrial ecology.
3 credit hours; senior standing in engineering or permission of the instructor.

Class Schedule

Date	Topic	Assignments/Activities
Aug 31	Introduction. Overview of topics for class, objectives, format, projects, grading. What is "sustainable" and "sustainability?" What tools are available to answer these questions?	Introductory readings in class (The Priest and the Prophet, Sustainability Principles and Practice for Engineers, New Conceptual Hierarchy for Sustainability Metrics). One-minute paper – what do you want to get out of this class? Group discussions on meaning of sustainability, sustainable engineering.
Sep 7	Life Cycle Analysis	1. Matthews et al - Environmental and Economic Effects of E-Commerce 2. Hocking - Relative Merits of Polystyrene Foam and Paper in Hot Drink Cups 3. ISO 14040 - LCA Principles and framework HW 1 – due September 14
Sep 14	Life Cycle Analysis	Attend "Power to the People" university dialogue on Energy. 1. Udo de Haes et al - Three Strategies to Overcome Limitations of LCA 2. Lave et al - Using IO Analysis to Estimate Economy Wide Discharges HW 2 – due September 21
Sep 21	Life Cycle Impact Analysis	Hendrickson et al – Environmental LCA of Good and Services case studies

		1. LCA of residential buildings in the US 2. LCA of midsize passenger car 3. Environmental impacts of services HW 3 – due September 28
Sep 28	Full cost accounting, decision analysis and decision making	Powerpoint presentation on FCA. Provided a series of abstracts on valuation of externalities related to energy production, solid waste management, rail vs. air transport, fish farming, community planning. Handed out appendix from Eshet et al. (2006) that gives brief overview of many valuation methods.
Oct 5	Energy	Basic review of thermodynamics, energy and power. Carnot engines, steam power cycle, CHP systems, heat pumps, dessicant cooling, building heat transfer.
Oct 12	EXAM 1	
Oct 19	Low Impact Design LID	Integration of stormwater considerations into planning and site development. Details of low impact design methods.
Oct 26	Alternative Energy	Graduate student presentations on alternative energy sources.
Nov 2	Green buildings, LEED	Speaker from Oak Point Associates
Nov 9	Energy Audits	Speaker from PSNH, EnergyEffeciency Plus
Nov 16	Green buildings: design elements	
Nov 30	Environmental Management Systems: ISO 14001	
Dec 8	Project presentations	

Selected readings given every week. Paper(s) must be read prior to class and students prepared to discuss. Quizzes will be given. The schedule will be updated with assignments and readings as the semester progresses.

Grading: grades will be based on contribution to class discussions (20%), performance on quizzes and homework (20%), two exams (40%) and the project (20%).

Graduate students enrolled in CiE 897 will have additional responsibilities in their projects and will also contribute to class by presentation of selected subjects during the semester.

Projects are open-ended. They will be small group (2-5 people) projects, with deliverables tailored to the project. In all cases final oral presentations will be made to the class and a written report will be required.

39. Materials for Water Treatment Systems

University of Illinois: Urbana-Champaign

SUMMARY

Offered by: Civil and Environmental Engineering, Mechanical Science and Engineering
Instructor(s): Mark Shannon

Number of times taught: Three or More
Class size: 10 to 30
Class format: 4 hours of lecture per week

Portion of course focused on sustainable engineering: 10 to 25%

Student Level: Graduate
Students' Major: 60% Civil and Environmental Engineering, Mechanical Science and Engineering
20% Other engineering
20% Non engineering

UIUC ME 598/ CEE 598 MS/WT Prof. Shannon Spring 2008

Materials for Water Treatment Systems

OBJECTIVES

The objective of the *Materials for Water Treatment Systems* course is to educate students so that they are able to work at the interface of materials and water purification. This course will develop fundamental concepts related to the aqueous interface between materials and water that includes constituents normally found in source waters, such as salts, natural organic materials, pathogens, and industrially-derived contaminates. Fundamental mechanisms of interactions of water and constituents with materials will be presented, including separation mechanisms, absorption/desorption, ion exchange, reversible and irreversible chemical reactions in heterogeneous material systems, and transport phenomena. Property-structure relationships of materials required for differing water treatment modalities will be presented. This course will also review classical materials used in water treatment systems, introduce emerging materials and water purification methods for the removal of priority pollutants and mitigation of foulants. The intent of this class is to allow in-depth study of the complex interactions between aqueous species and materials for water purification systems.

SCHEDULE:
Lectures: MW 8:00-9:50 in 410 B1 (Studio) Engineering Hall, UIUC

INSTRUCTOR: Prof. Mark A. Shannon, 2130 Mech. Eng. Laboratory, 1-217-244-1545
e-mail: mshannon@uiuc.edu (accessible via e-mail for questions and appts.)
Office hours: Mon. 10-11 am, Fri. 2-3 pm, and by appt.

Credit: 4 hrs. **PREREQUISITES:** Graduate standing, or consent of Instructor.

REFERENCE S FOR FURTHER STUDY:

Desalination and Water Purification Technology Roadmap, The National Academies Press, 2004.
Water Treatment Principles & Design, 2nd, Crittenden, Trussell, Hand, Howe, and Tchobanoglous, 2005
Water Treatment Handbook, 6th Edition, Degremont, 1991.
Chemistry of Water Treatment, 2nd Edition, Samuel D. Faust, 1998.
The Drinking Water Handbook, Frank R. Spellman, 2000.
Waste Water Engineering Treatment and Reuse, 4th Edition Metcalf & Eddy, Inc., G. Tchobanoglous, F.L. Burton, H.D. Stensel, McGraw Hill, Boston, 2003.
Ultrafiltration and Microfiltration Handbook, Munir Cheryan, 1998.
Fundamentals of Filtration, A Technical Primer, 2nd Edition, P.R. Johnson, 1998.
Modern Tools and Methods of Water Treatment for Improving Living Standards Series: Nato Science Series IV: Earth & Environmental Sciences V48, A. Omelchenko, A.A. Pivovarov, W.J. Swindall, 2005.
Natural Organics Removal Using Membranes: Principles, Performance, and Cost, A. Schafer, 2001.
Wastewater Microbiology, 2nd Edition, Gabriel Bitton, 1999.
Membrane Technology in Water and Wastewater Treatment, Edited by P. Hillis, 2000.
Brock Biology of Microorganisms, 10th Edition, M. Madigan, J. Martinko, J. Parker, 2002.
Seawater Desalination Processes: Operations and Costs, T. M. Pankratz, 2002.
Disinfection By-Products in Drinking Water: Form, Analysis, and Control, Yuefeng Xie, 2002.

GRADING:

There will be no homework or exams. A term paper will be due at the end of the semester. The grade will be based on the term paper and the 15 minute presentation of the work near the end of the class. The term paper involves writing a journal or thesis quality paper on a subject that is directly related to an aspect of the class participant's research or work. The topic will be jointly decided.

WEBSITE:

There is a web-site for this class to access the lectures and archives. The URL is http://online.engr.uiuc.edu/webcourses/cee-me598wt/

UIUC ME 598/ CEE 598 MS/WT Prof. Shannon Spring 2008

Syllabus of Topics

(I) Issues in Water Purification – (1 lec.) *NAS Report 2004*

- (a) Supply, contaminants, and pathogens – Impact
- (b) Technical and Scientific Objectives
- (c) Role of New Material and System Development

(II) Constituents in Source Waters – (1 lecs.) *Degremont, Faust, Spellman, Tchobanoglous*

- (a) Physical Characteristics
- (b) Inorganic non-metallic
- (c) Metallic
- (d) Organic
- (e) Microbial

(III) Water Treatment Processes – (4 lecs.) , *Crittenden, Degremont, Spellman, Tchobanoglous*

- (a) Basic physical-chemical processes in water treatment and purification
- (b) Physical unit operations and materials/systems currently used
- (c) Chemical unit operations and materials/systems currently used
- (d) Basic biological processes in water treatment: aerobic and anaerobic
  - Fundamentals of biological treatment
  - Attached growth and combined biological treatment processes
- (e) Homogeneous vs. heterogeneous processes
- (f) The role of the aqueous interface in water treatment

(IV) Fundamental Mechanisms of Interactions between Materials, Water and its Constituents – (11 lecs.) *Cheryan, Degremont, Johnson, Omelchenko, Schafer*

- (a) Separations methods and mechanisms
- (b) Filtration
  - Media, theory, properties
  - Microfiltration, ultrafiltration, nanofiltration, reverse osmosis
- (c) Absorption and desorption of species in separation media
- (d) Ion exchange and separation
- (e) Reversible and irreversible chemical reactions in heterogeneous material systems
- (f) Transport phenomena from normal to nanoscale
- (g) Thermal and electrical phenomena
- (h) Property-structure relationships of materials for different water treatment modalities
- (i) Fouling of materials: Scaling and biofouling

(V) Water Purification Methods and Materials Issues – (8 lec.) *Bitton, Hillis, Madigan, Pankratz, Tchobanoglous, Xie*

- (a) Desalination and reuse
  - Thermal
  - Membrane
- (b) Toxin and contaminant removal from different source waters
  - Trace contaminants in high background constituents
  - Conversion and disposal
  - Sensing
- (c) Disinfection
  - Heterogeneous chemical reactions
  - Photochemical
  - Byproducts
- (d) Emerging materials and water purification methods

UIUC ME 598/ CEE 598 MS/WT Prof. Shannon Spring 2008

Tentative Schedule of Topics

Week	Monday	Wednesday	Activities
1 (1/13)	*On-line only* (1) I.a-c (1/14)	*On-line only* (2) II.a-e (1/16)	(a) Introduction to water purification: Why we care.
2 (1/20)	(3) *MLK Holiday* (1/21)	(4) III.a-b (1/23)	(b) What is in source waters?
3 (1/27)	(5) III.b-c (1/28)	(6) III.c-d (1/30)	(c) How water is cleaned now?
4 (2/3)	(7) III.d-f (2/4)	*On-line only* (8) IV.a (2/6)	*Term Topic Due 2/6/2008* (d) Interactions between materials and water
5 (2/10)	(9) IV.b (2/11)	(10) IV.c (2/13)	(e) Basics of separation and filtration
6 (2/17)	(11) IV.d (2/18)	(12) IV.e (2/20)	(f) How things stick and move in filters and materials
7 (2/24)	(13) IV.f (2/25)	*On-line only* (14) IV.g (2/27)	*1st Draft of Intellectual Outline Due 2/25/2008* (g) Exchanging and reacting
8 (3/2)	(15) IV.h-i (3/3)	(16) IV.i (3/5)	(h) Transport phenomena in materials and systems
9 (3/9)	(17) IV.i-j (3/10)	(18) IV.j-k (3/12)	*2nd Draft of IO Due 3/12/2008* (i) Governing properties Scaling and fouling
10 (3/16)	*Happy*	*Spring*	*Break!*
11 (3/23)	(19) V.a (3/24)	(20) V.a (3/26)	(j) Methods and Issues of Materials in Purification
12 (3/30)	(21) V.a (3/31)	(22) V.b (4/2)	(k) Desalination and reuse
13 (4/6)	*On-line only: ACS Presentations* (23) V.b (4/7)	*On-line only: ACS Presentations* (24) V.b (4/9)	(l) Contaminant removal
14 (4/13)	(25) V.c (4/14)	(26) V.c (4/16)	(m) Disinfection
15 (4/20)	(27) Presentations (4/21)	(28) Presentations (4/23)	(n) Presentations
16 (4/27)	*Last Class* (29) Presentations (4/28)	(30) Presentations (4/30)	*Term Paper Due 5/2/2008* *Have a Great Summer!*

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40. Materials Selection for Clean Technologies

Cornell

SUMMARY

Offered by: Mechanical and Aerospace Engineering
Instructor(s): Matt Miller

Number of times taught: information not provided
Class size: Less than 10, 10 to 30, 30 to 100, More than 100
Class format: 2.5 hours of lecture per week

Portion of course focused on sustainable engineering: information not provided

Student Level: Upper division
Students' Major: ≥90% Mechanical and Aerospace Engineering

MAE 4XXX, Materials Selection for Clean Technologies
MAE Course Proposal
Matt Miller
March, 2008

Clean technologies use limited or zero non-renewable resources or create less waste than their conventional counterparts[1]. The four Clean Tech sectors: energy, transportation, water and materials encompass established technologies such as solar photovoltaic cells and wind power as well as emerging methods such as tidal power. In these days of $100 a barrel oil and overflowing landfills, the alternative technologies of the 1970's have emerged as viable, affordable options. Our discipline (Mechanical Engineering) is placed squarely in the center of the Clean Technology revolution. Many environmentally conscious topics will no longer be optional for the next generation of mechanical engineers. A mechanical engineer will be expected to understand and account for the environmental impact of a design regardless of his or her personal environmental beliefs.

From selecting materials that will enable more efficient conversion of wind and solar energy to understanding mechanical properties of new *green* materials, material selection is a fundamental way to affect the manner in which a design interacts with the environment. And while materials and chemical engineers often play the fundamental role in the design and synthesis of new materials, materials selection for mechanical design is a decidedly **mechanical engineering** enterprise. Understanding the optimal set of material properties for a mechanical design requires proficiency at many of the fundamental mechanical analysis techniques that are in the required MAE core curriculum courses. Deciding which materials satisfy those needs – with additional environmentally-based design constraints and objectives (such as improved efficiency and life cycle design) – is the major goal of this course. We will build off of the fundamentals of failure analysis and materials selection the students acquire in MAE212 and the understanding they gain regarding solution of boundary value problems in MAE325. We will also conduct mechanical tests on various green materials, such as emerging biocomposites made right here at Cornell. The culmination of the course will be a material selection and conceptual design project for a key Clean Technology-relevant component.

This course will complement other energy and environment focused courses such as MAE401, Components and Systems: Engineering in a Social Context and MAE 402, Wind Power. It should be a Engineering Materials concentration course.

[1] *The Clean Tech Revolution*, Pernick and Wilder, 2007.

Department, number, and title of course: MAE4XXX, Materials Selection for Clean Technologies

Designation as a 'Required' or 'Elective course: Elective (Engineering Materials concentration). Optional credit as a 429 senior design elective.

Course (catalog) description:
Advanced material selection concepts, which build off of the fundamentals of materials index developed in MAE212 and MAE325 including process and shape selection, hybrid materials and industrial design. The course begins with a very brief overview of current Clean Technologies and the basics of life cycle and environmentally conscious design. There are two main technical themes in the course: 1) application of materials selection basics and concepts of life cycle design to current design limitations associated with various clean technologies and 2) determination of the mechanical properties of various emerging green materials including mechanical tests on green materials

Prerequisite(s):. MAE212, MAE325, MAE327 (co-requisite)

Textbook(s) and/or other required material:
Required Text: Ashby, *Materials Selection in Mechanical Design*, Third Edition
Required Software: Cambridge Engineering Selector (license was purchased in MAE212)
Other resources (not required): Pernick and Wilder, *The Clean Tech Revolution*
Kutz, *Environmentally Conscious Mechanical Design*

Course objectives:
On completion of this course, students should:

1. Have an increased understanding of the materials selection process for mechanical design based on the fundamentals developed in MAE212 and MAE325 (ABET a, e, k).
2. Understand fundamental concepts of Clean Technologies including the current limitations and design opportunities in the areas of solar energy, wind power, biofuels, vehicles, mobile power sources and others. This includes life cycle and environmentally conscious design. (ABET f, h, j)
3. Understand current manufacturing limitations associated with various Clean Technology components and the concept of material life cycle (ABET a, h)
4. Conduct mechanical property determination experiments on various "green" structural materials (ABET b)
5. Conduct a conceptual design focusing on material selection for an enabling component from the Clean Tech areas of solar energy, wind power or personal vehicles (ABET a, c, e, g, h)

Topics covered:

- Overview and current state of clean technologies concepts.
- Review of the material index concept and the fundamentals of function, constraint and objective approach to mechanical design (from MAE212). Review of mechanical analysis process associated with mechanics of materials (from MAE212 and 325).
- Advanced topics in materials selection: multiple constraints, selection of material and shape and designing hybrid materials.
- Application of materials selection fundamentals to clean, sustainable technologies focusing on critical components from solar energy, wind power and personal vehicles.
- Mechanical properties of green materials and selection of materials considering material life cycle.
- Manufacturing and materials processing associated with Clean Technologies

Class/laboratory schedule, i.e., number of sessions each week and duration of each session: Three 50-minute lectures each week. The laboratory component of the course – mechanical tests on green materials - will be conducted in lieu of several lectures.

Contribution of course to meeting the professional component: This course partially fulfills the requirement to complete three upper level M&AE courses as a Field Approved Elective. The course may be used to fulfill the Technical Elective requirement and, with an optional one hour design project, can serve as a senior design elective, MAE 429.

Relationship of course to program outcomes: This course meets ABET Outcomes a, b, c, e, f, h, and j.

Outcome Assessment:

- Knowledge of fundamental principles is assessed by homework assignments and prelims (Objectives 1, 2, 4)
- Competence in problem identification, formulation, and solution will be assessed by open ended problem assignments including a conceptual design (Objective 5)
- Competence in use of mechanical testing, data acquisition and analysis techniques is assessed by evaluation of a laboratory report (Objective 3).
- At the end of the course, students will be asked to complete a course evaluation.

Person(s) who prepared this description and date of preparation: Matt Miller, 3/1/08

41. Minimizing Industrial Emissions

University of Minnesota

SUMMARY

Offered by: Environmental Sciences, Policy, and Management
Instructor(s): Sangwon Suh and Cindy McComas

Number of times taught: Twice
Class size: 10 to 30
Class format: 3 hours of lecture plus 2 hours of “other” contact per week

Portion of course focused on sustainable engineering: More than 50%

Student Level: information not provided
Students’ Major: information not provided

ESPM 3606/5606 Minimizing Industrial Emissions (3 credits)
9:45 A.M. - 11:00 A.M., Tues/Thurs (09/04/2007 - 12/11/2007), 13 Rapson Hall (for a map see http://onestop.umn.edu/Maps/RapsonH/)

Instructors
Sangwon Suh & Cindy McComas

Office and Office hours
Sangwon Suh (sangwon@umn.edu):
BAE 224, 1390 Eckles Ave, Saint Paul, MN 55108; Friday, 10-11 AM

Cindy McComas (mccom003@umn.edu):
Minnesota Technical Assistance Program (MnTAP), McNamara Alumni Center, 200 Oak Street SE, Suite 350, Minneapolis, Minnesota 55455 – 2008, Monday, 9 -10 AM

Catalogue description
Industrial facilities use raw materials and resources and emit pollutants and wastes. Both purchasing input materials and treating and disposing pollutants and wastes create not only environmental problems but also costs to a firm. In this class, students will have an opportunity to learn ways industries can reduce their industrial emissions as well as costs by preventing pollution. Students will be introduced to the concept and techniques of pollution prevention and will gain knowledge and skills essential in implementing a pollution prevention project in the field. Related concepts including cleaner production, design for the environment, and life-cycle management will be dealt with, and practical examples will be illustrated. Speakers from local industries will be invited to talk about their field experiences and real-life cases. The course is comprised of (1) lectures by the instructors, (2) presentations by guest speakers from local industries, (3) a field trip, and (4) hands-on exercises and group activities.

Course objective
The principal objective of this course is to help you develop basic skills of problem solving in the areas of pollution prevention. This includes developing a solid understanding of pollution prevention concepts, identifying problems, formulating plausible questions, developing innovative ideas, developing proper analytical skills, working as a team, and communicating with others. You will also become more familiar with the real-life situations in industries where these concepts, tools and ideas are applied in practice.

Text
The main text book is the “Pollution Prevention—Fundamentals and Practice” by Paul L. Bishop (10-digit ISBN: 1-57766-348-9; 13-digit ISBN: 978-1-57766-348-5). The textbook is available from major on-line and off-line book stores.

Other relevant course materials will be distributed during the course or will be available through the WebCT. Following is a list of complementary information sources.

- National Pollution Prevention Roundtable (NPPR) Web Site http://www.p2.org/

- National Institute for Science and Technology Manufacturing Extension Program (NIST MEP) Web Site http://www.mep.nist.gov/
- Small Business Development Centers (SBDC) Web Site http://www.sba.gov/aboutsba/sbaprograms/sbdc/index.html

- EPA Environmentally Preferable Purchasing (EPP) Program http://www.epa.gov/opptintr/epp/
- EPA Environmental Accounting Project http://www.epa.gov/opptintr/library/pubs/archive/acct-archive/
- EPA Design for Environment http://www.epa.gov/dfe/
- EPA P2 Programs and Initiatives http://www.epa.gov/opptintr/p2home/
- EPA P2 Resource Exchange (P2Rx) http://www.p2rx.org/
- EPA Sustainable Industry http://www.epa.gov/sustainableindustry/
- State P2 Programs http://www.epa.gov/opptintr/p2home/pubs/assist/index.htm

Late Work
All assignments must be submitted to Sangwon Suh or Cindy McComas by 5 p.m. on the stated date. Late work will be penalized one grade notch (e.g., 1 grade point) for each day it is late. The weekend counts as one day.

Course plan

Week	Lecture	Date	Topic	Principal Instructor	Assignments (due next class)
1	1	9/4	Introduction / Organization of the class	S	Textbook chapter 3
	2	9/6	Industrial emissions and their impacts (Part 1)	S	
2	3	9/11	Industrial emissions and their impacts (Part 2)	S, C	
	4	9/13	Overview of pollution abatement facilities/technologies (Part 1)	S	Pollution control technology write up
3	5	9/18	Pollution abatement facilities/technologies; Economics of pollution abatement (Part 2)	S	Textbook chapter 4; CAAA timeline; Recent environmental regulatory case
		9/20	NO CLASS	S and C gone	
4	6	9/25	Environmental regulations and P2 integration	C (S gone)	Textbook chapter 1; Introductory P2 readings
	7	9/27	Introduction to pollution prevention Background on group assessment project/presentation	C (S gone)	Pollution prevention technology write up
5	--	10/2	Quiz	S and C	

				gone	
	8	10/4	Pollution prevention tools	C (S gone)	Textbook chapter 8; Process flow diagram on everyday activity
6	9	10/9	P2 planning, assessments, and process flow diagrams	C	
	10	10/11	Accounting for materials and energy flows of a facility	S (C gone)	Textbook chapter 7
7	11	10/16	Accounting for materials and energy costs and implementation of P2 / Total cost analysis	S	Textbook chapter 5
	12	10/18	Industry specific case studies – Procedures	C	
8	13	10/23	Industry specific case studies – Process	C	
	14	10/25	Industry specific case studies – Product	C	
9	15	10/30	Eco industrial parks	S	Textbook chapters 6 & 14
	16	11/1	Life cycle analysis	S	
10		11/6	**Midterm**	S, C	
		11/8	Cenex case presentation for paper	C, S	Cenex paper due 11/20
11		11/13	Industry speaker: Denise Kazmierczak, Andersen Corp	C (S gone)	
		11/15	Industry speaker: Heather Tansey, 3M--3P Program	C (S gone)	
12		11/20	Industry speaker: Mike Reznicek, Tennant	C, S	
13		11/27	Field trip to District Energy or Tennant Company	C, S	
		11/29	Preparation for student group assessment presentations	S, C	
14		12/4	Student group assessment presentations	S, C	
		12/6	Student group assessment presentations	S, C	
15		12/11	Student group assessment presentations	S, C	

Grading criteria

Participation	10%
Quiz	5%
Midterm exam	15%
Short paper (Cenex)	20%

Homework	20%
Group project and presentation	30%
Total	100%

Attendance Policy
You are required to attend every class session, field trips, guest lectures, exams and student presentations. Each unexcused absence is cause for one point grade reduction in the participation score. **More than three unexcused absences** is cause for a failing grade.

To secure an excused absence, you must:

- To the best of your ability, contact the instructors before class to explain why you will be absent and to request an excused absence; and have a legitimate reason for absence as defined by the University of Minnesota. You must provide written documentation as soon as is reasonably possible. According to UMN policy, legitimate absences are for:
    - verified illness (**not** routine checkups!)
    - participation in athletic events or other group activities sponsored by the University
    - serious family emergencies
    - subpoenas
    - jury duty
    - military service
    - religious observances

Arriving at the class later than 15 min after the start of the class is considered as an absence unless the aforementioned criteria for excused absence are met.

Grading Scale
A= 90 to 100 percent; B= 80-89; C= 70-79; D= 60-69; F= less than 60

All the member of a group will acquire the same grade for the “Group project and presentation” part, unless contributions by individual members are reported to be substantially different among the members.

Academic integrity
Academic integrity is essential to a positive teaching and learning environment. All students enrolled in University courses are expected to complete coursework responsibilities with fairness and honesty. Failure to do so by seeking unfair advantage over others or misrepresenting someone else's work as your own, can result in disciplinary action.

SCHOLASTIC DISHONESTY: submission of false records of academic achievement; cheating on assignments or examinations; plagiarizing; altering, forging, or misusing a University academic record; taking, acquiring, or using test materials without faculty permission; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement.

Within this course, a student responsible for scholastic dishonesty can be assigned a penalty up to an including an "F" or "N" for the course. If you have any questions regarding the expectations for a specific assignment or exam, ask.

Cm/word/class/syllabus
(8/6/07)

42. Modeling of Resources Utilization for Sustainable Engineering

University of Kentucky

SUMMARY

Offered by: Mechanical Engineering and Manufacturing Systems Engineering
Instructor(s): Dusan Sekulic

Number of times taught: Once
Class size: Less than 10
Class format: 2 hours of lecture plus 1 hours of discussion plus 1 hour of "other" contact per week

Portion of course focused on sustainable engineering: More than 50%

Student Level: Graduate
Students' Major: ≥90% Mechanical Engineering and Manufacturing Systems Engineering

ME 699: MODELING OF RESOURCES UTILIZATION FOR SUSTAINABLE ENGINEERING

(Thermodynamics for Sustainable Manufacturing)

SPRING 2008
Syllabus

Class Time: TuTr, 12:30 PM – 1:45 PM MFS 699 Section 002 Location: 414A CRMS Bldg
ME 699 Section 002 Location: 414A CRMS Bldg
TuTr 04:00 PM – 5:00 PM (An alternate time for individual work) Location 414A

Instructor: Professor Dusan P. Sekulic; 414F CRMS Bldg; voice: 257-2972; E-mail: sekulicd@engr.uky.edu.

Catalog Data 2005-06: A detailed investigation of a topic of current significance in mechanical engineering.
Introduction: Modeling of Resources Utilization for Sustainable Engineering is designed to provide advanced analysis tools for modeling of energy and materials resources utilization for sustainable engineering. Focus is on manufacturing technologies and processes. The course will offer a methodical approach to critical study of energy and materials utilization in manufacturing processes involving in particular mass and energy balancing. The basic indicators of sustainability to be considered will be: material intensity, energy intensity, and pollutant (including toxic) emissions. The material covered includes: (1) prediction and assessment of resources utilization for selected manufacturing processes, (2) model building of energy resources utilization vs. production rate for a given manufacturing process, (3) model building for recycling, and (4) case studies involving manufacturing processes. Modeling of resources utilization will be based on novel exergy modeling concepts, utilization of thermodynamics metrics and thermo economic principles.

Topics:
1. Introduction
2. Basic Principles (Materials processing and energy, material, exergy, and entropy)
3. Thermodynamic analysis of manufacturing systems (Life cycle assessments and laws of thermodynamics, exergy analysis)
4. Entropy generation as a measure of resource consumption in life cycle assessment
5. Sustainability metrics (definitions, entropy based metrics in green engineering)
6. Entropy and recycling
7. Exergy and environmental impact of manufacturing processes
8. Exergy and material flow in manufacturing systems
9. Entropy, economics and policy
10. Case studies

Goal:
Familiarize students with a synergistic approach to sustainability issues through the use of advanced thermodynamics tools.

Educational Outcomes:
At the completion of this course students should:
1. Understand resources utilization issues in mechanical engineering and in particular in manufacturing
2. Master the methodology of exergy analysis of resources flows through open manufacturing systems.
3. Apply basic mass, energy and exergy balancing along life cycle of material flows and products for evaluation of sustainability indicators of manufacturing processes.
4. Develop skills for predicting of desired directions of processes evolution and development of new technologies characterized with reduced sustainability footprint.

Final Grade:

(1) Reading Assignments	**3 times 10% (total 30%),**
(2) Seminar Assignments:	**2 times 15% or 1 time 30%,**
(3) Project Assignment (Case Study)	**40 %**

43. Multicriteria Sustainable Systems Analysis

Rochester Institute of Technology

SUMMARY

Offered by: Golisano Institute for Sustainability
Instructor(s): information not provided

Number of times taught: information not provided
Class size: information not provided
Class format: information not provided

Portion of course focused on sustainable engineering: More than 50%

Student Level: Graduate
Students' Major: information not provided

Rochester Institute of Technology
Rochester, New York

GOLISANO INSTITUTE FOR SUSTAINABILITY

NEW COURSE PROPOSAL
Multicriteria Sustainable Systems Analysis (5001-XXX)

1.0 **Title**: Multicriteria Sustainable Systems Analysis **Date**: Oct. 3, 2007
Credit Hours: 4
Prerequisite(s): none
Corequisite(s): none
Course proposed by: P. Stiebitz

2.0 **Course information:**

	Contact hours	Maximum students/section
Classroom	4	30
Lab	0	NA
Studio	0	NA
Other (specify ________)	0	NA

Quarter(s) offered (check)
_____ **Fall** _____ **Winter** __X__ **Spring** _____ **Summer**

Students required to take this course: (by program and year, as appropriate)
First year Sustainability Ph.D. and M.S. students

Students who might elect to take the course:
Students who are interested in sustainability and the environmental aspects of manufacturing, production and other industrial activities will take this course. Several different types of students are expected to enroll, including:

- Graduate students and exceptional undergraduate students throughout RIT seeking electives in sustainability or preparing to participate in research related to sustainability; and
- Qualified employees of area manufacturing, engineering, or environmental services firms, as well as government employees, seeking additional education related to sustainability and environmental management, engineering and/or design.

3.0 **Goals of the course (including rationale for the course, when appropriate):**
This is a core course within the Sustainable Production Systems Ph.D. and M.S. programs. It introduces and applies methods in systems analysis, tradeoffs, and decision making in the context of multicriteria issues in sustainable production systems by building on basic decision analysis concepts introduced in 5001- XXX Understanding Risk from a Sustainability Standpoint. Students requiring

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additional depth or breadth in this topic area to support their research will likely take additional coursework as electives.

All students will be required to complete a term project that applies subject matter principles and methodologies to one or more of the following areas: Smart Products, Cleaner Production, Sustainable Product Design, Sustainable Energy Systems, Life-Cycle Logistics, Sustainable Business Strategies, Remanufacturing, Recycling, or Resource Recovery.

4.0 Course description (as it will appear in the RIT Catalog, including pre- and co-requisites, quarters offered)

5001-XXX Multicriteria Sustainable Systems Analysis

This is a core course within the Sustainability M.S. and Ph.D. programs. It introduces and applies methods in systems analysis, tradeoffs, and decision making in the context of multicriteria issues in sustainable production systems by building on basic decision analysis concepts introduced in 5001-XXX Understanding Risk from a Sustainability Perspective. Students requiring additional depth or breadth in this topic area to support their research will likely take additional coursework as electives. (Enrollment in the Sustainable Production Systems program or permission of instructor) Class 4, Credit 4 (S)

5.0 Possible resources (texts, references, computer packages, etc.)

5.1 Hobbs, B.F. and P. Meier, <u>Energy Decisions and the Environment - A Guide to the Use of Multicriteria Methods</u>, Springer.
5.2 Herath, G. and T. Prato, <u>Using Multi-criteria Decision Analysis in</u>
5.3 <u>Natural Resource Management</u>, Ashgate Publishing.
5.4 Glaser, B., <u>Efficiency versus Sustainability in Dynamic Decision Making: Advances in Intertemporal Compromising</u>, Springer.
5.5 Seager TP, et. al., "Application of Multicriteria Decision Analysis in Environmental Decision Making," <u>Integrated Environmental Assessment and Management,</u> 1(2):95-108, 2005.
5.6 Szekely, F. (2005). "Responsible Leadership and Corporate Social Responsibility: Metrics for Sustainable Performance". <u>European Management Journal</u>, Vol. 23. No 6. 628 -647.

6.0 Topics (outline):

6.1 Multidimensional issues in sustainable production systems – case studies

6.2 Formulating single objective problem statements
  6.2.1 Survey of sustainable production metrics
  6.2.2 Qualitative sustainable production criteria
  6.2.3 Quantifying sustainable production objective functions

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6.2.4 Developing constraint sets

6.3 Formulating multiobjective sustainable production problem statements
6.3.1 Serial decision representations – decision trees
6.3.2 Aggregating multiple decisions into multiobjective statements

6.4 Formulating alternative solutions to problems in sustainable production systems
6.4.1 Using structured methods to identify alternatives

6.5 Prioritizing sustainable production criteria
6.5.1 Screening alternatives
6.5.2 Paired comparison methods

6.6 Choosing among alternatives solutions to problems in sustainable production systems
6.6.1 The Analytical Hierarchy Process
6.6.2 Mathematical optimization methods

6.7 Analyzing the stability of solutions

6.8 Decision support for predictive maintenance

6.9 Decision support for end-of-life decisions

6.10 Decision support for life-cycle tradeoffs

7.0 Intended learning outcomes and associated assessment methods of those outcomes

Students will be introduced to the theoretical basis for multicriteria systems analysis techniques and be able to employ them in numerous areas, such as:

7.1 to model and improve complex industrial-environmental-social systems with respect to sustainability objectives
7.2 to create causal models of sustainable production problems
7.3 to utilize multi-criteria decision making methods to arrive at solutions to sustainable production problems
7.4 to develop decision models under uncertainty and apply them in life cycle tradeoff analysis
7.6 to assess the business risks and opportunities related to sustainable production
7.7 to anticipate and ameliorate unintended consequences of proposed solutions to sustainable production problems
7.9 to integrate life cycle information into sustainable production decision-making
7.10 to minimize energy consumption throughout a product-system life-

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cycle
7.11 to minimize material consumption throughout a product-system life-cycle the manufacturing and remanufacturing process
7.12 to minimize waste through a product-system life-cycle

8.0 Program or general education goals supported by this course

8.1 Given that most environmental and sustainability issues are the direct or indirect result of industrial activities, core courses in the Ph.D. and M.S. programs in sustainable production will focus on optimizing industrial systems;

8.2 Core courses in the Ph.D. and M.S. programs in sustainable production will take a holistic view of problems and solutions specifically addressing economic, social, and environmental risks and benefits;

8.3 Optimization of industrial systems will focus on the minimization of material and energy resources, maximization of expended resources, and the minimization of adverse impacts;

8.4 The Ph.D. and M.S. programs in sustainable production and core courses will be based on broadly defined multidisciplinary teamwork;

8.5 The Ph.D. and M.S. programs in sustainable production and core courses will focus on applied, rather than theoretical, aspects of sustainability;

8.6 The Ph.D. and M.S. programs in sustainable production and core courses will address solutions to global issues.

8.7 Core courses shall include introductory elements pertinent to some of the following research focus areas:
8.7.1 Smart Products Systems - develops the architectures, business models, logistics, technologies, and designs of product systems that have the ability to maintain a record of information such as its configuration, usage history, repair history, and remanufacturing history and can utilize this information to determine its own end-of-life disposition. Smart technologies also enhance the sustainability of manufactured goods by adding economic value, reducing environmental impacts and strengthening the social networks of smart product users;
8.7.2 Cleaner Production - the investigation of improvements in production process that minimize the consumption of energy, water, expendable toxic substances, and generation of environmentally harmful waste;
8.7.3 Sustainable Product Development - research focused on design

processes and methodologies that considers all life-cycle phases (including material extraction, service, and end-of-life disposition), in order to balance functionality, cost, impacts, and quality tradeoffs throughout the product realization cycle;

8.7.4 Sustainable Energy Systems - This research focus area investigates the life-cycle sustainability implications of alternative energy systems including the production, use and end-of-life of alternative energy technologies and the interdependency of energy systems on other economic, environmental and social systems

8.7.5 Life-Cycle Logistics – focuses on the operational challenges of managing forward and reverse supply chains at each life-cycle stage;

8.7.6 Remanufacturing, Recycling, and Resource Recovery (R3) - focuses on the development of remanufacturing processes, product take-back strategies, business models for remanufacturing, and market and policy impacts; and

8.7.7 Sustainable Business Strategies – research focused on integrating smart product strategies, closed-loop supply chain strategies, sustainable product development methodologies, life-cycle logistics, market/societal requirements, and R3 into innovative new businesses and product platforms.

9.0 Other relevant information (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)
None.

10.0 Supplemental information
None.

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44. Nanotechnology, Biology, Ethics and Society

California Polytechnic State University

SUMMARY

Offered by: Materials Engineering
Instructor(s): Linda Vanasupa and Matthew Ritter

Number of times taught: Three or More
Class size: 30 to 100
Class format: 4 hours of discussion per week

Portion of course focused on sustainable engineering: 25 to 50%

Student Level: Undergraduate, lower and upper division (9:1)
Students' Major: 50% Materials Engineering
50% Non engineering

EdGE — Serving Society Through Innovation

BIO 232 – NANOTECHNOLOGY, BIOLOGY, ETHICS AND SOCIETY
MATE 232

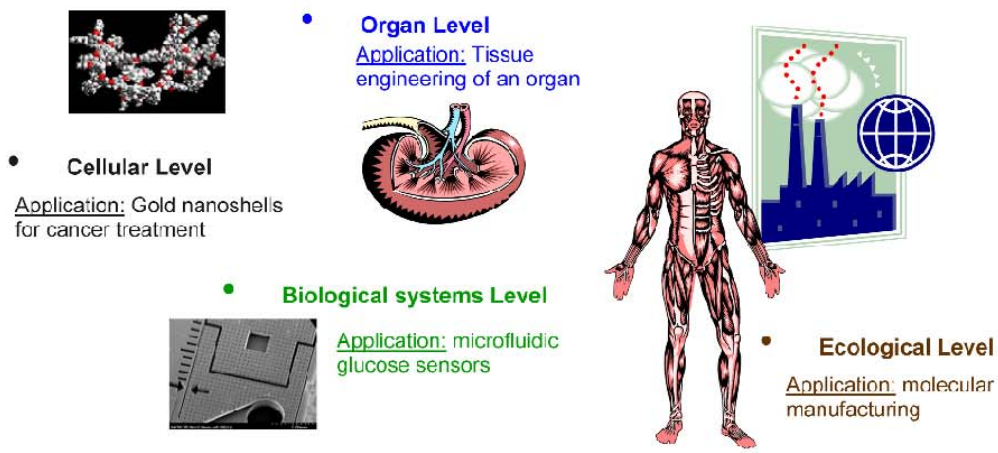
Course Syllabus

Instructors

M. Ritter, Ph.D., Office phone: 756-2775, Building 33-363 email: mritter@calpoly.edu
L. Vanasupa, Ph.D., Office phone: 756-1537, Building 41-229, email: lvanasup@calpoly.edu

Course Topics

During the course of the quarter, we will explore four specific technology areas, represented pictorially in the diagram above. Our planned schedule is:



Our planned schedule for the non-multidisciplinary coursework is:

week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week 10
Ecological level									
		Cellular Level							
				Organ Level					
						Biological Systems Level			
								Team debates	

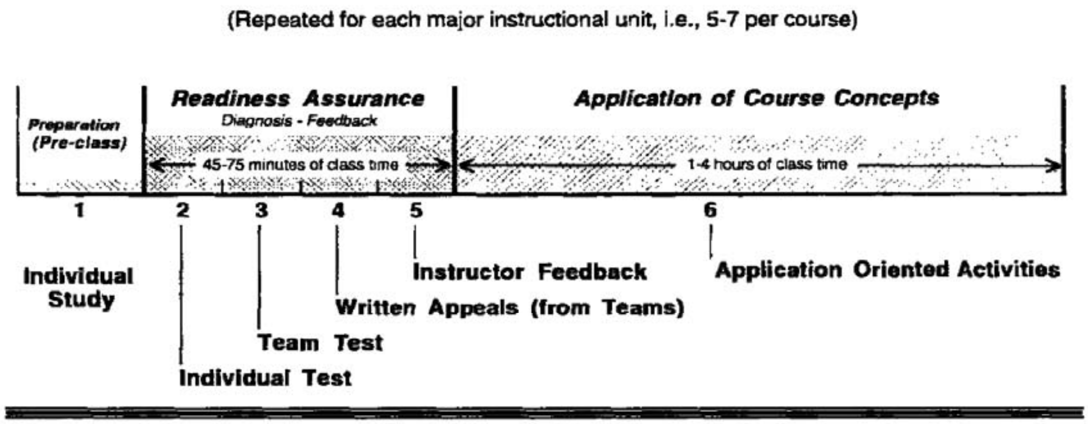
Reading Materials

Most of the course reading materials will be available on-line through Blackboard (www.mycalpoly.edu) in BIO232. Students will need to supplement their knowledge with other resources, available through the library.

Time Investment Expectations

This course is 4 lecture units. You will be expected to prepare before coming to class. Class time will be used to work on team assignments.

EXHIBIT D–A4
Team-Based Learning Instructional Activity Sequence



QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Grading
Your grade will be based on a straight scale (80% and up-A, 80% to 90%--some version of a B, etc.). You will negotiate some aspects of your grade weighting. Please fill in the results of the negotiation below.

Category of Development	*Minimum Limit*	*Maximum Limit*	*Negotiated Percentage of Total*
Individual Development (ID) Achievement on learning assessments (in-class quizzes) and end of quarter debate.	40	65	
Team Development (TD) (Achievement on team quizzes, debate and group assignments) x (individual contribution factor*)	35	60	

*Scored by teammates. All others, scored by faculty.

45. Natural Resource Consumption and Sustainability

University of Minnesota

SUMMARY

Offered by: Environmental Sciences, Policy, and Management
Instructor(s): Sangwon Suh

Number of times taught: Twice
Class size: 30 to 100
Class format: 4 hours of lecture plus 2 hours of "other" contact per week

Portion of course focused on sustainable engineering: More than 50%

Student Level: information not provided
Students' Major: information not provided

ESPM Natural Resource Consumption and Sustainability
Course Syllabus

===

Spring 2008 **Sangwon Suh**
College of Food, Agricultural and Natural Resource Sciences **University of Minnesota**

===

Course Title: Natural Resource Consumption and Sustainability
Day/Time: Monday, Wednesday, Friday 10:40 A.M. - 11:55A.M
Meeting Room: Andrew Boss Lab, Room 125 (St Paul Campus)—Room changed!

===

Instructor: Sangwon Suh, Assistant Professor
224A BAE building
612-624-5307
Office Hours: Fridays 10:30 – 11:30 AM or by appointment
Email: sangwon@umn.edu

Teaching assistance Ryan Barker
112 BAE building
612-624-4915
Office Hours: Wednesday 9:00 – 10:15 AM
Email: bark0166@umn.edu

===

Course Description: This course consists of a combination of lectures, contemporary readings, videos, and classroom discussion.

Learning Objectives: 1. To expose students to current
- world populations trends and associated demand trends
- sources of supply for industrial raw materials.

2. To examine environmental and other tradeoffs related to various options for satisfying demand/needs for industrial raw materials.

3. To introduce the concept of global and systematic thinking as a way of beginning to deal with complex environmental problems.

4. To provide a framework for students to begin a process of critical thinking about environmental problems and possible solutions.

===

Main course content: 1. Sustainability
Perspectives
I=PAT equation
Inter and intra-generation equity

2. Population
Trends and overview
Global, regional and local levels
Associated cultural, social and economic issues

3. Daily bread
Trends and overview
Agricultural production and productivity

Land use, fertilizer consumption and ag-chemical uses

4. Energy consumption
   - Trends and overview
   - Alternative energy
   - Economic and environmental repercussions

5. Natural resource management policy
   - Industrial Ecology
   - Closed-loop economy
   - Resource productivity and material flow analysis

6. Metals and minerals
   - Trends and overview
   - Material cycles and industrial ecology
   - Material flow analysis and policy issues

7. Wood and fiber
   - Trends and overview
   - Systems thinking – demand and supply; conservation and forest age; tradeoffs

8. Homeostasis
   - Trends and overview
   - Earth system and life-supporting function
   - Climate change

9. Consumption, life and welfare
   - Trends and overview
   - Consumer economy
   - Inter and intra-generation equity

10. Outlook
   - Institution-building and international coordination
   - Resources productivity and closed-loop economy
   - Q Technology, culture and life style changes
   - What we can do

==

Required Materials: Required readings are compiled in a class packet available at the St. Paul Bookstore. Two copies of this packet are on reserve at the Forestry Library in Skok Hall.

Some required readings are on reserve at the Forestry Library in Skok Hall.

Required readings via websites are listed in the Schedule.

==

Supplemental Reading: Some additional articles will be assigned during the semester. They will be on reserve at the Forestry Library in Skok Hall. Notice of these readings will be given through the class WebCT site and announced in class.

==

Reading Assignments: Reading assignments are indicated on the Course Schedule. It is important that all readings be completed prior to the class session for which the readings are assigned. Reading assignments not contained in the course packet can be found on the internet as pdf files on the class website.

==

Lecture Notes — Power point presentations used as part of class lectures will be posted to the class web site within 24 hours of the corresponding class session.

==

Grades will be based on:

- 5 Quizzes (total 20%)
- Mid term (20%)
- Group project (20%)
- Final Exam (comprehensive) (30%)
- Class discussion participation and attendance (10%)

Quizzes will be mainly on the reading materials and can be on any class days. Each will have 4% point.

Exams will be closed book. The tests will be a combination of multiple choice, short answer, matching, and essay.

Group project will be on a survey of the current status and the future prospect of a resource of the group's choice. It can be any fossil energy resources such as coal and crude oil, any mineral and metal resources such as iron, titanium, rhodium and indium, or any renewable resource such as water, wind and solar energy. The group project will be presented to the entire class.

Only in an emergency will a student be allowed to make-up an exam. If you have such an emergency, you must notify the instructor in person *before* the exam. If you have a conflict with the final exam, please notify me as soon as possible.

The final letter grade will be based on straight percentages as follows:
A= 90 to 100%; B= 80-89; C= 70-79; D= 60-69; F= less than 60

Academic Honesty: Students are responsible for maintaining academic integrity by submitting his or her own original work. All suspected cases of academic dishonesty will be vigorously pursued through the College of Food, Agriculture, and Natural Resource Sciences Honor System.

==

Policies: <u>Attendance</u>. Students are expected to be in classroom during the class hours; this means coming to class on time and staying to the end. You should read through reading material on a topic prior to class and be prepared to discuss any and all assigned article in class.

An attendance list will be circulated during each class. A name tent will be at the back of the room. You are asked to pick up your name tent and place it front of you during the class period. Return it to the back of the room at the end of class.

Respect. You are expected to be attentive during class, ask questions if you do not understand something, and to offer your opinion. You are also expected to listen respectfully to other students and to me when speaking. Racism, sexism, homophobia, classism, ageism and other forms of bigotry are inappropriate to express in this class.

Computer use in class. Computer may be used in class to take notes. Connection to the internet during class time is prohibited.

Attendance. Each unexcused absence is cause for one point grade reduction in the participation score. Three or more unexcused absences is cause for a failing grade, i.e. an "F".

==

Course website: An orientation site for using Vista can be accessed at: http://uttc.umn.edu/training/resources/webct/vista/start.html

To skip the orientation and go directly to the course web site, use the following url: http://vista.umn.edu/webct/entryPage.dowebct

In both cases, you will need your X500 name and password to gain entry.

If you have any disability that might affect your performance in this class, you are encouraged to speak with me at the beginning of the term.

46. Perspectives on Cities: Cities and Energy

University of Dayton

SUMMARY

Offered by: History, Mechanical and Aerospace Engineering, Physics, and English
Instructor(s): Heitman and Bednarek (HST), Hallinan (ME), Brecha (PHY), and McCombe (ENG)

Number of times taught: Twice
Class size: 30 to 100
Class format: 3 hours of lecture per week

Portion of course focused on sustainable engineering: 10 to 25%

Student Level: Undergraduate upper and lower division (1:1)
Students' Major: information not provided

ASI 320 – Perspectives on Cities: Cities and Energy
A VTS Cluster offering in the History Domain

Class Meeting: MW 3-4:15 p.m., HM 125

Instructors: Janet Bednarek, Department of History
John A. Heitmann, Department of History
Kevin Hallinan, Department of Mechanical and Aerospace Engineering
With a guest appearance from Dr. John McCombe, Department of English

Offices:
Dr. Heitmann -- 466 HM (x92803)
Dr. Bednarek – HM 464 (x92824)
Dr. Hallinan – KL361B (92835)

Office Hours:
For John Heitmann:11:00-11:50 MW or by appointment
E-Mail: *John.Heitmann@notes.udayton.edu*
Home page: *http://homepages.udayton.edu/~heitmann/*
For Janet Bednarek: MW 1-2:45 or by appointment.
Email: janet.bednarek@notes.udayton.edu
Home page: http://academic.udayton.edu/JanetBednarek

Text: David E. Nye, *Consuming Power: A Social History of American Energies* (2001).
Barbara Freese, *Coal, A Human History* (2004).
Adam Rome, *The Bulldozer in the Countryside: Suburban Sprawl and the Rise of American Environmentalism* (2001)
There are also materials under Heitmann in E-Reserve

Grades: The final grade for this course will be based upon two Hour Exams, (40%), A Term Paper (20%), and Final Exam (20%), Occasional Reading Responses (20%). The grade scale is as follows: A 94 to 100; A- 90 to 93; B+ 87-89; B 84-86; B- 80 - 83; C+ 77-79; C 74-76; C- 70-73. A similar pattern applies to lower grades. Letter grades are assigned a mid-point numerical grade. Additionally, attendance can influence your final grade: if you miss more than 3 classes, one letter grade will be deducted from your grade; if you miss more than 6 classes, a two letter grade reduction will take place. A good grade for this course is a C+. Grade averages may be influenced by such factors as trends over the time of the course; for example, how you finish is far more important than how you start. Policies for exams strictly follow History Department Guidelines, and make-ups will only be offered with a valid, documented excuse. Exams will be constructed in such a manner that essay percentages reflect the contributions of each faculty member during the course unit; faculty will only grade their specific questions(s), but every effort will be made to ensure consistency.

Term Papers: A term paper assignment will be an important component of this course. It should be 8 to 10 pages, doubled spaced, in length, and should employ 8-10 sources with MLA style citations. Honors section student should aim at papers of 15 pages in length, with 12-15 sources.. It is not acceptable to hand in a paper that has been written for another course. Key to the success of this project is that of topic choice. A list of approved topics will be distributed on February 19; however, if you have your own idea for a paper topic, it can be pursued subject to faculty approval. We will have a term paper proposal assignment at mid-term that should help you with focus, themes, and sources.

Attendance at lectures is crucial if you are to expect a good grade in the course, and I want you to be at every class if that is at all possible. On many occasions material presented is not covered in the readings, and so many of the ideas discussed central to the development of modern science are complex and often confusing. Your attitude and what you bring in to the classroom can make the difference between a mediocre offering and a most positive educational experience.

Cheating and plagiarism will not be tolerated and offenses will be punished accordingly. A first offense will result in a failing grade for the exam or paper in question; a second offense will result in a failing grade for the course. Penalties are subject to faculty discretion. Further, **it is totally unacceptable to hand in a paper that is the result of work in another class**.

Course Purpose: This course is one of five that are being developed and offered (Fall, 2006 – "Cities and Suburbs" was taught by a faculty team led by Dr. Pat Donnelly) that seeks to address a broad spectrum of issues that cities bring into focus. An interdisciplinary team of faculty will delve into historical relationships, both idealized and real, between the country and the city. Energy transitions over time will be examined that center on the changing reliance on human and animal power, water, fossil, and nuclear sources. We will look at the role of energy in each environment and particularly at the growth of cities since the Industrial Revolution, their dependence on an unprecedented abundance of energy, a wide range of positive and negative effects of this phenomenon, and how an inevitable change in energy resources may affect human life in a future that is increasingly focused in cities. Currently there is no more important issue than that of our dependence on non-renewable sources of energy.

SCHEDULE OF LECTURES AND ASSIGNMENTS

The week of:

Week 1/January 7/9 Introduction of Faculty and a Description of what Each of Us Will Bring to the Course; *What is a City?* (Bednarek)
Readings: Janet Bednarek, "What is a City?"

Week 2/January 14/16 *What is Energy?*(Hallinan); *Energies of Conquest* (Heitmann)

Readings: Howard T. Odum and Elisabeth C. Odum, *Energy: Basis for Man and Nature* (McGraw Hill, 1976), Introduction; Chapter 1 ("Systems of Energy Flows"); Chapter 2 ("What is Energy?); Chapter 3, ("Principles of Energy Flows.") John R. Fanchi, *Energy in the 21st Century* (World Scientific, 2005), Chapter 1 ('Brief History of Energy Consumption"). David E. Nye, *Consuming Power: A Social History of American Energies*, Chapter 1 ("Energies of Conquest").

January 21 **Martin Luther King Day**

Week 3/January 23 *The City, and the Countryside (Heitmann)*
Reading: Nye, Chapter 2 ("Water and Industry')

Week 4/January 28 *The Industrial Revolution I* (Bednarek); January 30: *Poetic Response to the 19t Century City I* (McCombe)

Reading: For January 28: Nye, Chapters 3 ("Cities of Steam"); For January 30: Wordsworth's "Preface to Lyrical Ballads"; Selected poems by Wordsworth, including "Simon Lee," "Lines Written in Early Spring," "Expostulation and Reply," and "The Tables Turned."

Week 5/ February 4/6 *Industrial Revolution II*; *Poetic Response II*

Readings: For February 4: Chapter 4 ("Power Incorporated"). For February 6: "Wordsworth's "Lines Composed a Few Miles above Tintern Abbey," and "Sonnet Composed upon Westminster Bridge." Also Samuel Taylor Coleridge's "This Lime-Tree Bower My Prison," and "Frost at Midnight." All on E-Reserve.

Week 6/ February 11/13 – **TEST 1 on February 11**

February 13 Discussion on term paper assignment

Week 7/ February 18/20; Discussion of the Barbara Freese, *Coal: A Human History(Heitmann)*; *February 20: Gilded Age Cities (Bednarek)*

Readings: Barbara Freese, *Coal: A Human History*; Nye, Chapter 5 ("Industrial Systems").

Week 8/February 25/27 *Cities, Infrastructure. Sewers, Water Supplies, Bacteriology* (Heitmann)

Reading: Martin Melosi, The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present (Baltimore, 200), Chapters 4-7 ("Pure and Plentiful: From Protosystems to Modern Waterworks, 1830-1880;" "Subterranean Networks: Wastewater Systems as Works in Progress;" "On the Cusp of New Public Health: Bacteriology, Environmental Sanitation, and the Quest for Permanence, 1880-1920;" "Water Supply As a Municipal Enterprise, 1880-1920.")

Week 9/ February 3/5 *Cities in the Progressive Era* (Bednarek)

Readings: Nye, Chapter 6("Consumption and Dispersion'); Mark Rose and John G. Clark, "Light, Heat, and Power: Energy Choices in Kansas City, Wichita, and Denver, 190-1935," *Journal of Urban History* 5(May, 1979), 340-364; Harold L. Platt, "City Lights: The Electrification of the Chicago Region, 1880-1930," in Joel A. Tarr and Gabriel DuPuy, eds., *Technology and the Rise of the Networked City in Europe and America* (Philadelphia), 246-281.

Week 10/ March 10/13 *The Rise of the Petroleum Economy* (Heitmann);

Readings; "Fossil-Fueled Civilization," in Vaclav Smil, *Energy in World History*, Chapter 5, pp. 157-222.

March 13 – Test 2

March 17/19/24 – Mid Term Break!!!!

Week 11/ March 26 *The City and Everyday* Life (Bednarek)

Readings: Jean Christie, "Morris L. Cooke and Energy for America," in Carroll W. Pursell, Jr., *Technology in America*, 2nd edition, pp.237-247.

Week 11/12/ March 31/April 2 – (*The City and the Automobile* (Heitmann)?)

Readings: Kenneth Jackson, Crabgrass Frontier: the Suburbanization of the United States (New York, 1985), pp.157-171

Week 13/ April 7 *Nuclear Power and the City* (Bednarek, Heitmann, Hallinan)

Readings: Colin J. Campbell and Jean H. LaHerrere, "The End of Cheap Oil;" "Nuclear Reactors" (both on E-reserve); http://www.colorado.edu/physics/2000/isotopes/index.html.

Stander Symposium April 9 – No Class

Week 14/ April 14/19 Post-War Urban History/Suburbanization (Bednarek)

Readings: Nye, Chapter 7; Rome, *The Bulldozer in the Countryside: Suburban Sprawl and the Rise of American Environmentalism..*

Week 15/ April 21/23 *Oil Shock; Global Warming and Energy Crisis* (Heitmann and Hallinan)

Reading: Nye, Chapter 8 ("Energy Crisis and Transition'), Chapter 9 ("Choices").

Week 16/April 23/25 *Creating a Green City* (All)
Reading: Howard T. Odum and Elisabeth C. Odum, "The Prosperous Way Down," *Energy*, 31 (206), 21-32; Jonas Åkerman and Mattias Höjer, "How Much Transport Can the Climate Stand? -- Sweden on a Sustainable Path in 2050," *Energy Policy*, 34 (2006), 1944-1957.

April 23— Term Paper is due; Last Class

Final Exam is Monday, April 28, 12:20 p.m. to 2:10 p.m.

47. Pollution Prevention: Principles and Practice

University of Nebraska-Lincoln

SUMMARY

Offered by: Civil Engineering
Instructor(s): Bruce Dvorak

Number of times taught: Three or More
Class size: 10 to 30
Class format: information not provided

Portion of course focused on sustainable engineering: More than 50%

Student Level: Upper division and graduate (17:3)
Students' Major: 25% Civil Engineering
70% Other engineering
5% Non engineering

Biological Systems Engineering/Civil Engineering 422/822
Pollution Prevention: Principles and Practice
May 21 – August 10, 2007

The textbook **Guide to Industrial Assessments for Pollution Prevention & Energy Efficiency**, EPA/625/R-99/003 June 2001, may be accessed at http://www.epa.gov/ORD/NRMRL/Pubs/2001/energy/complete.pdf.

Faculty:

Bruce Dvorak
W358 Nebraska Hall and 229 L.W. Chase Hall
Phone: (402) 472-3431
e-mail: bdvorak@unl.edu

Dennis Schulte
216 L.W. Chase Hall
Phone: (402) 472-3930
e-mail: dschulte1@unl.edu

Pollution Prevention Extension Staff

Stacey Hawkey
234 L.W. Chase Hall
Phone: (402) 472-2838
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Valdeen Nelsen
234 L.W. Chase Hall
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Hunter Flodman
W328 Nebraska Hall
Cell: (402) 276-2717
e-mail: h_flodman@yahoo.com

Patrick Denning
W328 Nebraska Hall
Cell: (402) 770-4875
e-mail: patdenning@gmail.com

Pollution Prevention Partners/Resources

NDEQ
1200 N St. Suite 400
Lincoln, NE 68508
Phone: (402) 471-2186
http://www.deq.state.ne.us

WasteCap Nebraska
285 S. 68th St. Place, Suite 540
Lincoln, NE 68510
Phone: (402) 436-2384
http://www.wastecapne.org

P2RIC
6001 Dodge St., RH 308
University of Nebraska-Omaha
Omaha, NE 68182
Phone: 402-554-6257
http://p2ric.org

P3 Training Timeline

First Session May 21 – June 1

May 21	Training starts 1:00 pm in Nebraska Hall Room W129, City Campus
May 26-28	Memorial Day holiday begins after class Friday, May 25
June 1	Final day of first training session
June 4	Most interns begin field work; Focus Group meeting for selected students (see schedule)
June 6	Pizza and discussion of site visit reports for selected students (see schedule)

Mid-Summer Session July 2-3

July 2	Begin late morning in LW Chase Hall, meetings and focused training in Lincoln; mid-summer report due
July 3	Workshops and individual meetings (adjourn mid-afternoon)
July 4	Holiday
July 5-6	Field work continues

Final Session August 9-10

August 8	Last day for field work
August 9	Debriefing meetings & program evaluations; final report due
August 10	Final presentations; banquet dinner in the evening

11/2/2008

Grading Policy

		Undergrad Credit	Graduate Credit
1 .	Homework prepared during two-week class	15%	15%
2 .	Quizzes	5%	4%
3 .	Site Visit Report	15%	15%
4 .	Class attendance and involvement in two-week class	5%	4%
5 .	Mid-summer report (due during mid-summer meeting)	10%	10%
6 .	Final project report & achievement of assistance objectives	40%	45%
7 .	Final project presentation	10%	7%

Notes:

1 . All homework assignments and reports must be turned in at the time assigned. Late homework and reports will have 10% deducted from the grade per school day (unless prior arrangements have been made with the faculty). Homework and reports turned in late will not always be returned at the same time as the homework turned in on time.

2 . Final grades will be assigned on the standard scale (97 – 100 = A+, 93 – 96 = A, 90 – 92 = A-, 87 – 89 = B+, 83 – 86 = B, 80 – 82 = B-, 77 – 79 = C+, 73 – 76 = C, 70 – 72 = C-, 67 – 69 = D+, 63 – 66 = D, 60 – 62 = D-, 0 – 59 = F).

Expectations

We have some expectations of you that go beyond the obvious things like turning in homework and reports.

1) We expect you to be curious. We will ask you a lot of questions and we hope and expect you to do the same.
2) We expect you to participate in class discussions and to be thinking during the lectures, discussions and when you are providing technical assistance.
3) All calculations should be on engineering paper.
4) You are expected to bring to all class meetings your notebook and the resource materials provided to you during this program.
5) We expect you to learn from each other. Thus, we encourage people to work together in small groups (2 to 3 people), provided it is a mutual learning experience for all involved. Direct copying of another's work is not allowed. If one person has already solved a problem, and you have put in a good-faith effort on it but still cannot solve it, it is acceptable for that person to teach you how to solve it. However, it is not acceptable for him/her to simply give you their paper/program/ spreadsheet as a guide.
6) We expect flexibility from the students.
7) We expect you to be on time for classes.

Goal for BSEN/CIVE 422/822

To provide students with formal training as well as practical experience in the application of pollution prevention and waste minimization techniques in business and industry.

Student Interns for Summer 2007

Student Name	Project	Location	Major	School
Gregory Arthur	Lincoln City Water	Lincoln	CE	UNL
Sean Brozek	Duncan Aviation	Lincoln	ChE	UNL
Carol Faulhaber	ADM	Columbus	AgE	Iowa State University
Melissa Golden	Red Willow Ext./Sm Business	McCook	BioE	University of Missouri-Columbia
Deborah Hemphill	ASA Biofuels	Albion	ChE	Kansas State University
Dean Herl	IA Team	Lincoln	IE/MfgE	Kansas State University
Damon Mar	Dutton-Lainson	Hastings	ME	University of Kansas
Cassie McBride	Tri-Con Industries	Lincoln	ChE	UNL
Brandi Munsinger	WasteCap NE/IA Team	Lincoln	ChE	UNL
Katherine Ring	Cornhusker Energy	Lexington	EnvE	University of Missouri-Rolla
Thomas Soucie	Molex	Lincoln	IE	UNL
Jason Thoendel	Lancaster Co. Ext./Small Business	Lincoln	BSE	UNL
Lauren Tietgen	NuCor	Norfolk	IE	UNL

Class Only Students for Summer 2007

Keith Derr	AASF Facility	Lincoln	EE	UNL
Mahesh Pun	Sourcewater Protection	Lincoln	Env Eng	UNL

11/2/2008

Mornings in Room W130 Nebraska Hall (City Campus). Afternoons in Room 112 LW Chase Hall (East Campus).

Time	Mon., May 21
	NOTE: The first day of class we will meet in W129 Nebraska Hall to begin the afternoon.
1:00	**Welcome! Overview & Introductions**
1:45	**Keynote:** Joe Francis, NDEQ
2:15	**Intro to P2 & Sustainability** – Dvorak
3:00	**Introduction to Extension** – Vernon Waldren, SER&EC
3:45	**Review P2 Definition Homework** – Pegg/Flodman/Denning
4:15-5:00	**Summer Projects – Packets** Dvorak/Hawkey
5:30	**P3 Pizza & Movie Discussion: "An Inconvenient Truth"** – Piper Pit Niehardt Hall City Campus
	Homework: UNL EHS Training

Time	Tues., May 22
8:30	**Morning Review** – Hawkey/Dvorak
8:45	**"Cash in Trash" video** – Dvorak
9:30	**Benefits & Barriers of P2 & Mission Statements** – Pegg, Hakenkamp
11:00	**Info on Computer Labs** – Denning/Flodman
11:30	**Lunch**
1:00	**Laws & Regulatory Structure** – Hugh Stirts, NDEQ
1:30	**Environmental Regulations Overview/MSDS** – Hawkey
2:30	**Intro to Material Balances & Life Cycle Thinking** – Dvorak
4:30	**Afternoon Review** – Hawkey/Dvorak
	Homework: Regs/MSDS

Time	Wed., May 23
8:30	**Morning Review** – Hawkey/Dvorak EHS Training Homework Due
8:45	**Environmental Jeopardy** – Hawkey/Denning/Flodman
10:15	**Waste Assessments** – Dvorak
11:30	**Lunch & Work on Waste Assessment homework**
2:00	**Welcome to BSE** – Ron Yoder
2:10	**Importance of Documentation & Record Keeping** – Dvorak
2:45	**Discuss Homework** – Dvorak
3:15	**Assistance Mode Focus Groups**
4:30	**Afternoon Review** – Hawkey/Dvorak
	Homework: Waste Assessment

Time	Thurs., May 24
8:30	**Welcome** – Dr. Mohamed Dahab **Morning Review** – Hawkey/Dvorak
8:50	**Creativity Exercise** **Group Mission Statement & Design T- shirts** – Hawkey/Hakenkamp
10:00	**Management Report Outline** – Dvorak/Hawkey
11:00	**Intro to Site Visit & Safety During Assessments** – Hawkey/Denning
11:30	**Lunch**
1:00	**Site Visit #1: Combined Support Maintenance Shop (CSMS)** of the Nebraska Army National Guard
3:00	**Afternoon Review** – Hawkey/Dvorak
3:30-5:00	**Homework:** Work in small groups on waste assessment portion of Site Visit Management Report

Time	Fri., May 25
9:00	**Morning Review** – Hawkey/Dvorak Practice Assessment Reports Due
9:30	**WasteCap Nebraska** – Carrie Hakenkamp
10:15	**Intro to P2 Methods** – Dvorak
11:30	**Lunch**
12:30	**Intro to E2** – Kirk Conger
2:00	**Cost Analysis** – Dvorak
3:00	**Afternoon Review** – Hawkey/Dvorak
	Homework: Cost Analysis

GUEST SPEAKERS

Joe Francis
Nebraska Department of Environmental Quality (NDEQ), Lincoln
Vernon Waldren
Southeast Research & Extension Center, Omaha
Hugh Stirts
NDEQ – P2, Lincoln
Carrie Hakenkamp and Sue Ellen Pegg
WasteCap Nebraska, Lincoln
Kirk Conger
Facilities Management & Planning – UNL
Peter Stadig
Keep Nebraska Beautiful, Lincoln
Rick Yoder
P2RIC/P2Rx, Omaha
Chet McLaughlin
US EPA Region VII
Robb Maddox
Molex
Vincent Mancini
Cornhusker Energy
Mike Palmer
Shredding Solutions

11/2/2008

Mornings in Room W130 Nebraska Hall (City Campus). Afternoons in Room 112 LW Chase Hall (East Campus).

Time	Mon., May 28
	Memorial Day Holiday—no class

Time	Tues., May 29
8:30	**Morning Review –** Hawkey/Nelsen/Dvorak Return Practice Assessment Reports
9:15	**Sustainability & Life Cycle Assessment (LCA) -** Dvorak
11:30	**Lunch**
1:00	**Keep Nebraska Beautiful Material Exchange Program** – Peter Stadig (LW Chase Hall Computer Lab)
2:00	**Applied Research – P2RIC** Rick Yoder (LW Chase Hall Computer Lab)
3:00	**Application of P2 Methods & Finding Prescriptive P2 Materials** Flodman/Nelsen/Hawkey
4:30	**Documentation of Impact & Afternoon Review –** Hawkey/Nelsen/Dvorak/Flodman
	Homework: LCA homework

Time	Wed., May 30
8:30	**Morning Review –** Hawkey/Nelsen/Dvorak
9:00 – 11:30	**Site Visit #2 : Combined Support Maintenance Shop (CSMS)** of the Nebraska Army National Guard
11:30	**Lunch**
1:00	**"Sustainable??"** - Chet McLaughlin
2:00	**Report Writing Summary–** Hawkey/Nelsen
3:00	**Afternoon Review –** Hawkey/Nelsen/Dvorak
3:30	**Work on Site Visit Reports**
	Homework: Site Visit Report

Time	Thurs., May 31
8:30	**Morning Review –** Hawkey/Nelsen/Dvorak
8:45	**Management of Business Data & Confidentiality –** Nelsen
9:15	**Business Communication –** Hawkey
10:00	**Dealing with Businesses –** Panel Discussion with Vincent Mancini, Robb Maddox, Mike Palmer
11:30	**Lunch**
1:00	**Assistance Mode Focus Groups & Individual Meetings** **Work on Site Visit Reports**
	Homework: Site Visit Reports—due tomorrow

Time	Fri., June 1
8:30	**Morning Review –** Hawkey/Nelsen/Dvorak Site Visit Reports Due
8:45	**Reassessments –** Dvorak
9:45	**Final Reports & Impact Forms –** Dvorak/Hawkey/Nelsen
10:15	**Taxes and Send-off Items –** Hawkey/Dvorak
11:00	**P2 Presentations –** Dvorak/Hawkey/Nelsen/Flodman
11:30	**Lunch**
1:00	**Focus Group** (specific individuals) Dvorak/Hawkey
	Homework: P2 Presentations

Time	Mon., June 4**
Meet in Room TBD	
9:00	**Focus Group Meeting & P2 Presentations**

Time	Wed., June 6**
Meet in Room 112 at LW Chase Hall	
6:00	**Focus Group Meeting**

11/2/2008

(info needs to be confirmed—Hunter/Patrick?)
Computer Lab Hours & Information

Walter Scott Engineer Center Computer Lab

- *Hours*: Monday – Sunday: Open 24 hours a day
- *To access the lab*: If your UNL ID card does not open the lab, go to 114 Othmer Hall (bring you UNL ID) and ask that your UNL ID be updated.
- *To get a printing account*: Must sign up through an on-line request. The URL is **https://www.engr.unl.edu/ntaccount.html** . Printing accounts are not immediately activated.
- *Additional Notes*: Note the's' in the printing account URL. There are rarely computer technicians working in this lab. If a printer runs out of paper go to the Engineering Library (2nd floor Nebraska Hall) or Othmer Hall room 114 and ask for paper.

The WSEC computer lab is located on the ground level of the Walter Scott building, beneath the Nebraska Hall/WSEC link. The link is the large black walkway that connects the two main engineering buildings. The only way to access this lab is from the outside. To do this you must hold your UNL ID card in front of the card reader at the left of the entrance door. Once inside there will be two computer labs. Both labs have identical equipment so it does not matter which one you choose.

To print, you must select the print command from the main menu. The printer will say "Pipe2000". You must click on the drop down box and select the printer called "Gutenberg" to print regularly.

Nebraska Hall Computer Lab

- *Hours*: Monday – Sunday: Open 24 hours a day
- *To access the lab*: If your UNL ID card does not open the lab, go to 114 Othmer Hall (bring you UNL ID) and ask that your UNL ID be updated.
- *To get a printing account*: Must sign up through an on-line request. The URL is **https://www.engr.unl.edu/ntaccount.html** .
- *Additional Notes*: Note the's' in the printing account URL. There are not computer technicians working at this lab all the time. If a printer runs out of paper go to the Engineering Library (2nd floor Nebraska Hall) or Othmer Hall room 114 and ask for more.

This lab is located on the 2nd floor of Nebraska Hall, next to the library. To access the computer lab you must hold your UNL ID card in front of the card reader to the left of the door. When the building is not open (evenings & weekends) you can access Nebraska Hall by holding your UNL ID card in front of the card reader by the entrance to Nebraska Hall found under the building link.

LWC Computer Lab – Room 114

- *Hours:* Monday – Friday: 8:00 am – 5:00 pm
  Saturday & Sunday: Closed
- *To get a printing account:* UNL students should go to **http://activedir.unl.edu/** and register for an account. Be sure to remember your login name and password. You account should be active in about 10 minutes. Non-UNL students must be entered into the system manually. See the TA to get a printing account set up.

LW Chase Hall is on the northern-most edge of the East Campus Mall (the loop at approximately 35th and Holdrege). This lab is located to the right of the entrance area of the first floor of LWC Hall.

Cather/Pound Hall Computer Lab (Phone: 2-1093)

- *Hours*: Hours are unknown at this time.
- *To get a printing account:* At the logon screen, press Ctrl-Alt-Delete. Instructions should appear to obtain a printing account. Enter "student" as your login name and leave the password blank. Then go to **http://activedir.unl.edu/** and fill out the registration information. Be sure to remember your login name and password. Your account should be active in about 10 minutes. If you have any questions there should be a student working in the lab from noon – 6pm.

This lab is the closest one to the Niehardt Residence Hall (the hall many of you are staying in). Niehardt does not have computer labs available to all students. You must go to the nearby Cather/Pound Hall Computer Lab. To get there go east on the main floor of Niehardt. Go through the walkway to Cather/Pound to the stairs by the dining hall. Go down the dining hall stairs and walk left (towards Cather Hall). The computer lab is on the east wall.

Nebraska Union (City Campus) Computer Lab – Room 122 (Phone: 2-6632)

- *Hours:* Monday – Sunday: Open 24 hours a day.
- *Consultants are available:* Monday – Friday: 8:00 am – 10:00 pm
- *To get a printing account:* At the logon screen, press Ctrl-Alt-Delete. Instructions should appear to obtain a printing account. Enter "student" as your login name and leave the password blank. Then go to **http://activedir.unl.edu/** and fill out the registration information. Be sure to remember your login name and password. Your account should be active in about 10 minutes.
- *Additional Notes*: The Union offers only a dot matrix printer. This may not be what you want to use while printing out final versions of the homework or the P3 assessment report.

The Union is located on 15th & R Street. The lab is found on the first floor across from the Burger King. You must use your UNL ID card at the west entrance for after-hour access.

Additional computer labs can be found at http://www.unl.edu/cmplabs/ITG_lab_labs.htm

48. Renewable Energy Systems

University of Dayton

SUMMARY

Offered by: Mechanical Engineering
Instructor(s): Kelly Kissock

Number of times taught: information not provided
Class size: information not provided
Class format: information not provided

Portion of course focused on sustainable engineering: information not provided

Student Level: information not provided
Students' Major: information not provided

Renewable Energy Systems, MEE 473/573

Instructor: Kelly Kissock
Office: KL 363F W: 937-229-2852
kkissock@udayton.edu: www.engr.udayton.edu/faculty/jkissock
University of Dayton, Fall 2007

Logistics

Meeting time and place:	MW, 4:30-5:45, KL 221 Final Exam: Mon, Dec 10, 4:30-6:20
Office hours:	Anytime, drop-ins and appointments welcome
Text:	Simulating Renewable Energy Systems: Kissock
References:	Principles of Solar Engineering, Goswami, Kreith and Kreider
	Solar Engineering of Thermal Processes, Duffie & Beckman
	Renewable Energy, Johansson, Kelly, Reddy & Williams
	Renewable Energy: Power for a Sustainable World, Boyle

Course Goals

- To appreciate the importance of energy and renewable energy to our society.
- To acquire the knowledge and skills to model and design renewable energy systems.
- To improve our ability to solve engineering problems through the application of economic, heat transfer, fluid mechanic, and thermodynamic principles and the use of computers.
- To improve our ability to communicate technical information.

Grading

Homework (no late HW accepted; lowest score will be dropped)	80%
Final project	20%
Total (final grades curved)	100%

Students enrolled in MEE 573 will do additional readings and will be graded separately.
Please identify yourself if you require special accommodations to facilitate learning.

Overview

Affordable energy fueled the industrial age and is still the lifeblood of modern economies. And yet fossil fuels, which make up about 90% of all commercial energy, are limited by resource and environmental constraints. Currently, about 12% of US electricity is generated by renewable energy sources. As the market for "green" power grows and the efficiencies of renewable energy technologies increase, renewable energy technologies will provide an increasing fraction of our total energy supply; even now, global wind power and photovoltaic capacities are growing by 22% and 16% per year. This course will provide a technical introduction to the most promising renewable energy technologies of the 21st century: solar thermal, solar photovoltaic, wind power, and fuel cells. It's time to get current with the future!

Syllabus

Introduction	
Course Mechanics and Motivation	1
Overview of Renewable Energy Technologies and Potential	1
Solar Fundamentals	
Solar Radiation on a Tilted Surface	2
Active Solar Heating	
Useful Heat from Collectors	1
Active Solar Space Heating	1
Active Solar Water Heating	1
Active Solar Space and Water Heating	1
Active Solar Design Project	2
Passive Solar Heating and Lighting	
Solar Gain With Overhangs and Wings	1
Interior Air Temperature in Passive Solar Buildings	1
Daylighting	
Interior illumination from Skylights and Windows	1
Photovoltaic Systems	
Grid Connect PV Systems	1
Economics of PV Systems	
Solar Thermal Power	
Concentrating Collectors	1
Solar Thermal Power Systems	1
Wind Power	
Wind Turbine Performance Modeling	1
Economics of Utility Scale Wind Turbines	1
Fuel Cells and Biomass	
PEM Fuel Cells Performance	1
Economics of Fuel Cells and Biomass	1
Other Renewable Energy Systems	7
Introduction to Ocean Power	
Introduction to Power Towers	
Introduction to Solar Desalinization	
Introduction to Passive Solar Water HeatingPerferated Collectors	
Closure	1
Total	28

49. Solar Energy Utilization

University of Massachusetts, Lowell

SUMMARY

Offered by: Mechanical Engineering
Instructor(s): John Duffy

Number of times taught: information not provided
Class size: information not provided
Class format: on-line

Portion of course focused on sustainable engineering: information not provided

Student Level: Graduate
Students' Major: information not provided

22.521 Solar Energy Utilization, Fall, 2007

COURSE INTRODUCTION (rev. Aug. 22, 2007)

Conflicts in the Middle East and the anniversaries of Katrina and 9-11 remind us of the vulnerability of oil supplies and refining in the United States. Prices of gasoline have risen dramatically in the past few months. Alternative energy sources, being diffuse, provide at least some security and price stability since solar energy is free (although the systems to collect and transform it are not).

In this present day context, welcome to the Fundamentals of Solar Energy Utilization course. This course was developed by the Solar Engineering Graduate Program at University of Massachusetts Lowell (http://energy.caeds.eng.uml.edu). This is an on-line course in which you can learn the fundamentals of solar engineering: solar irradiation collection and utilization in different solar systems and technologies. The instructor of the course is John Duffy, Professor and Coordinator of the Solar Engineering Graduate Program (John_Duffy@uml.edu; 978-934-2968). These lessons are based on class notes and have been transcribed into word processor files, including original figures, by Juan Pablo Trelles and Peter Aurora. [I am grateful for their efforts—JJD.] The notes have been based on various textbooks, papers, web pages, and personal experience. References are given in appropriate chapters in this set of course material. This set of course material is hereby copyrighted ©2004.

The course will allow you to have an on-line interaction with the Solar Energy Program at UML. Because this is an on-line course, you can follow it according to your own schedule, to fit in with your professional and personal time commitments. Homework is due each Thursday (with a few exceptions) with the exact date indicated in parentheses for each lesson in the syllabus on the web. For example, the homework for Week 1 is due Sept. 14 via e-mail to the instructor. Note that the material is a bit "front-loaded" at the beginning of the semester to allow more time at the end for the miniproject, so allow enough time in the beginning. At the end of each chapter you are asked to answer a number of questions to test your comprehension of the material in the chapter. You should answer these successfully before proceeding to the next chapter. Feel free to ask questions of the instructor (John_Duffy@uml.edu).

Last semester, a number of students asked for a problem solving session once each week in the evening at a time convenient for all. Please contact me with a list of available evenings so we can schedule exams and whether you would like to have such a review session or not.

GOALS

Increase comprehension of fundamentals of solar irradiation and utilization as a function of location, receiving surface orientation, cloudiness, and time; of heat transfer in solar collectors; and of performance prediction of solar thermal systems.

OBJECTIVES

At the conclusion of this course, students will be able to:

- Calculate solar beam trajectory relative to collector surface as a function of location on earth, day of year, and time of the day.
- Estimate beam and diffuse components of solar irradiation based on measured global horizontal irradiation.
- Estimate solar energy transmitted, absorbed, and reflected by typical materials used in solar collectors (thermal or electrical).
- Estimate heat losses in flat plate collectors.
- Derive and use models of solar thermal system performance.
- Size a solar thermal system to meet a given daily load in a given location anywhere in the world.
- Estimate the energy collected in a parabolic collector given incident irradiation.

PREREQUISITE: heat transfer.

TEXT: Goswami, Kreith, and Kreider, 2000, *Principles of Solar Engineering*, Second Edition, Taylor and Francis, Philadelphia. NOTE: This text is not required but is useful. The variable labels used in the course notes are consistent with this text.

SOFTWARE: MathCad 11 (or later version) is necessary to be installed on the computer you are using to view the examples in the lessons from the web. It is very helpful in doing the homework problems and for answering the weekly quiz questions.

There will be two tests and a final exam at predetermined times during the semester. We will poll the class to make sure everyone will be available during the times of the tests. Unfortunately, we need to assign grades for this course. There are no predetermined percentages of students that will receive A, B, etc. We try to have objective standards. Therefore, there is no competition among students for grades. We try to have cooperative learning in this course, in which we help each other learn. There will be a group project, in which you will work with at least one other person in the course to apply the principles learned in the course on a “real” problem.

The breakdown of the final grade is as follows:

Two exams:	19% each
Final exam:	35%
Homework:	14%
Project:	13%

Please use the following protocol for file names for homework: hw#_#_name, where #_# is the problem number and name is your last name or your initials or nickname. For example, if I were turning in problem 1.2, I would label my file: hw1_2_jjd.

MINIPROJECT (topics tentative, final projects to be posted later in the course): Design a thermal collector to supply heat to a biodigester being built in Quian, Ancash, Peru; analyze hourly horizontal global irradiation from remote sites in Peru and extrapolate the results to monthly averages for other nearby sites and choose optimal slopes and azimuth angles for collectors.

Steps to obtain a username and password

- The URL for student login is http://continuinged.uml.edu/online/Confirmation/
- You will be sent a username and password within two days.

Preliminary steps to log into the course site (note we have switched from IntraLearn to WebCT or Blackboard) and more detailed instructions below):

1. Open your Internet connection (Explorer, Netscape, etc…)
2. In the URL Location/Address space type https://vappsrv-v4.umassonline.net/webct/entryPageIns.dowebct
3. Click on the "U Mass Lowell" button. Then "Log In."
4. Enter your username and password. Click on the "Log on" button.
5. Click on the name of your course.
6. Click the "Begin" button, located on the upper right corner.

If you encounter any technical problems with the WebCT (Blackboard) software, please contact Li Feng via e-mail Li_Feng@uml.edu or at 978/934-2927.

Lessons (homework due date)

CHAPTER 1: History, Review of Technologies; Energy Supplies and Environmental Effects (due 9-13)

CHAPTER 2.1: Extraterrestrial Irradiation; solar time (due 9-13)

CHAPTER 2.2: Angle Definitions, Shading (due 9-20)

CHAPTER 2.3: Terrestrial Solar Radiation, Tilted Surfaces (due 9-27)

CHAPTER 3.1: Heat Transfer: Black Body Radiation; Sky Radiation (due 10-4)

CHAPTER 3.3: Heat Exchangers (due 10-4)

CHAPTER 4.1: Absorptance, Emittance (due 10-11)

CHAPTER 4.2: Transmittance, Absorbed Irradiation (10-11)

CHAPTER 5.1: Flat Plate Collectors (10-18)

Midterm Evaluation (10-23 ??)

CHAPTER 5.2: Performance Tests, and Practical Considerations (11-1)

CHAPTER 6: Energy Storage (11-1)

CHAPTER 7.1-2: Design of Active Systems, Solar Collectors for Water Heating (11-8)

CHAPTER 7.3: Simulation of a Water Heating System (11-8)

CHAPTER 7.4: The f-chart Method (11-15)

Exam 2 (11-20 ??)

Miniproject (due 12-6)

CHAPTER 8: Concentrating Collectors (12-13)

Final exam (12-18 ?)

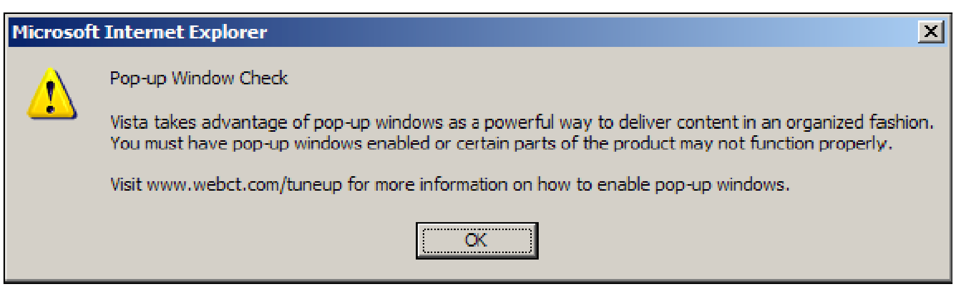
WebCT Access Information

How to get your WebCT username and password:

1) Go to http://continuinged.uml.edu/online and click on "Get Your Online Course Username/Password" link.
2) Follow on-screen instructions carefully to enter the information required to retrieve your username and password.
3) Print out the confirmation screen for your records.
4) To access your WebCT course supplement, go to the same website http://continuinged.uml.edu/online and click on the icon at the top left of the screen.

What you need to do when you first login:

1) When you first log into WebCT, pay particular attention to the warning messages that may come up. If you see a warning message about pop-up windows being disabled (similar to the one shown below):



You must turn off all pop-up blockers on your computer in order to use WebCT or allow pop-ups from the WebCT's website.

2) Run a browser check by clicking on "Check Browser" link at the top right of the screen:

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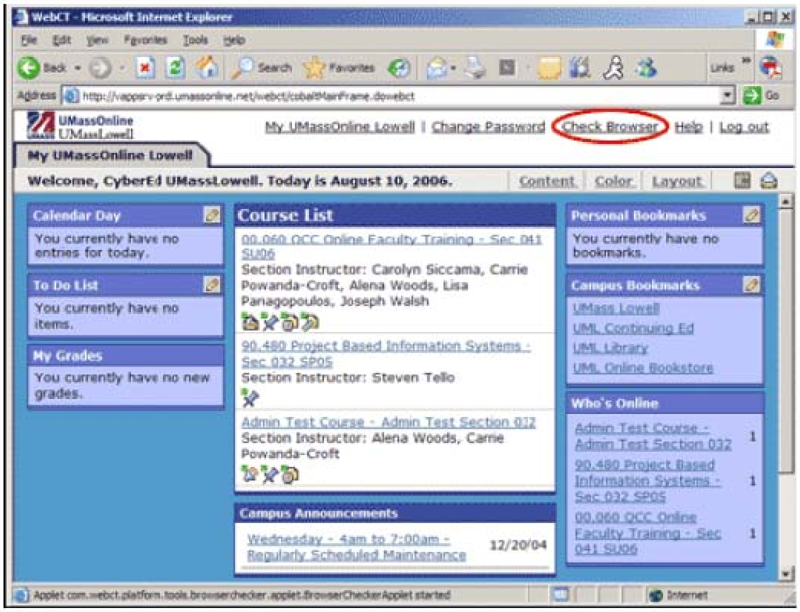
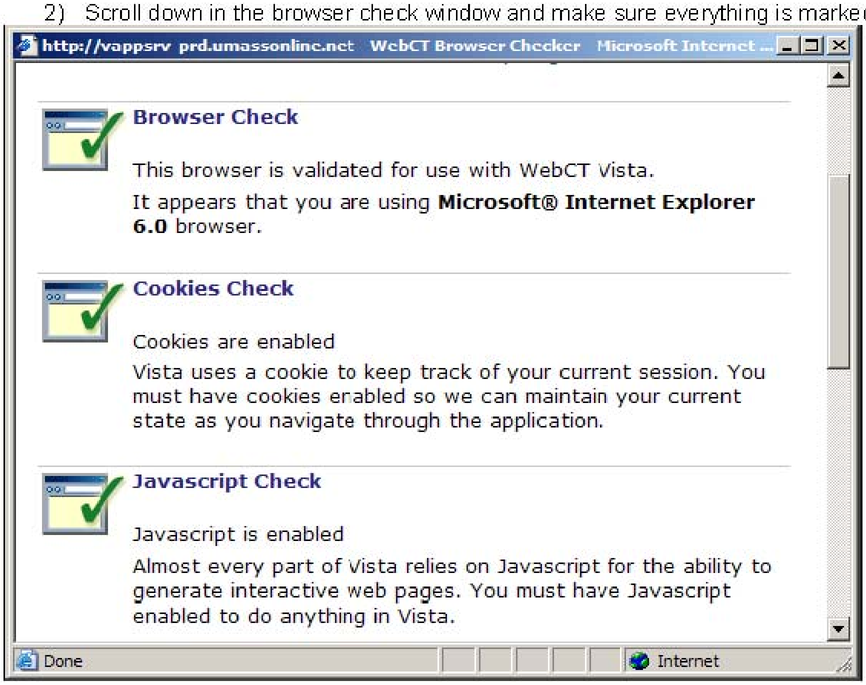


2) Scroll down in the browser check window and make sure everything is marked with a green check:



*If you see any red X's, follow the instructions at **the bottom of the window** to enable the necessary components.*

How to get technical help:

If you're having problems with WebCT, please contact Continuing Education Online Learning technical support:

Monday - Friday 8:30am - 5:00pm EST

Local Phone Number: 1-978-934-2467

Toll Free Number: 1-800-480-3190

Saturday, Sunday, Holidays and Monday - Friday 5:00pm - 8:30am EST

Toll Free Number: 1-800-569-650

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See 3 companion Word documents for remainder of this Appendix.