1. Instructor and TA

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2. Course Description

The course is intended to introduce students to the interaction between the human and natural environment, focusing on how the anthropogenic activities have altered the natural environment and provide an overview on the emerging science of **sustainability**. This course will identify the impacts associated with resource consumption and environmental pollution, and present the quantitative tools necessary for assessing environmental impacts and design for sustainability. At the end of the course, the students are expected to be cognizant about the concept of sustainability, the metrics of sustainability and be able to use the principles of sustainability in their respective field of practice.

3. Key Learning Points:

The key learning objectives would include:

- Indicators of Sustainability
- Earth Systems Engineering and Management
- Integration of the Environmental, Social and Economic Issues
- Life Cycle Analysis
  - Life Cycle Inventory
  - Risk and Impact Assessment
- Material Flow Analysis
  - Urban Metabolism
- Target Plots
- Industrial Ecology
- Urban Sustainability
- Dynamics of sustainability in the Developed and Developing world
- Agent-based Modeling
- Geoengineering
- Business Models of Sustainability

**Engineering Working Definition of Sustainable Development:**

Our socioeconomic system is far from sustainable and this may cause us guilt and perhaps frustration and so there may be a tendency to just give up. Consequently, we will use this definition for this class.

Roy F. Weston: “Sustainable Development is a *process of change* in which the direction of investment, the orientation of technology, the allocation of resources, and the development and functioning of institutions that meet present needs and aspirations without endangering the capacity of natural systems to absorb the effects of human activities, and without compromising the ability of future generations to meet their own needs and aspirations.”

A simpler working definition of sustainable engineering can be as follows:

*Sustainable Engineering is the design of human and industrial systems to ensure that humankind’s use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health and the environment.*

These requirements reflect that social conditions, economic opportunity, and environmental quality are essential if we are to reconcile society’s development goals with international environmental limitations.
4. Class Operation

This course involves active learning on the part of the students. The class will be broken up into groups. Each group will work together on homework and final project.

Prerequisites:

This course is meant to be taken by both engineering and non-engineering students. It requires basic mathematical skills, and the willingness to conduct quantitative analyses. Especially for the group project, students with different backgrounds may be called upon to contribute in different ways.

Attendance:

Students should sign in at the beginning of each class. A sign-in sheet will be provided by the instructor.

Grading:

Homework and Class Participation 25%
Mid-Term Exam 25%
Journal Article Critique 10%
Class Project 40%

Homework:

Homework is to be done individually but you certainly can seek advice from your group and others.

Homework Assignments Format:

1. Unless the problems are very short, begin each problem on a new sheet.
2. Always restate the problem indicating the given information, desired information and explain your method. Make liberal use of comments.
3. Make liberal use of sketches.
4. Always use units in your calculations and on graphs. For quantitative problems please underline the final answers.
5. Above all, BE EXTREMELY NEAT.
**Class Project:**

Class Projects are to be worked on as a group. They represent a group effort and each group will write a group report. Sustainable solutions will require coordinated collective efforts with stakeholders with diverse opinions and objectives. The group projects should be considered an opportunity to explore this approach.

The report should not be unnecessarily long, but should contain the following elements:

**Abstract.** Most technical journals require abstracts which summarize the content of a paper in one or two paragraphs. The abstracts may be written in the form used in the scientific Journals. Please include concluding remarks in the abstract. Every statement in the conclusion should be capable of undergoing careful scrutiny.

**Introduction.** The introduction should provide the reader with a concise statement of the theoretical and rational basis. It would be appropriate to follow the form frequently used in the scientific Journals for the introduction and succeeding sections.

**Approach.** The approach that was used to gather, analyze and synthesize a solution to the issue should be discussed in this section. If this section is written correctly, the results and discussion section will be more concise and will focus only on the presentation of the results and interpret the results.

**Results and Discussion.** Results should be summarized, tabulated, or plotted neatly. Particular attention should be paid to the units employed. S.I. units are preferred. Sample calculations should be shown. This section of the report gives greatest insight into the integrity of the writers. It is very easy to over interpret results. Caution should be observed in interpreting the results and alternatives should be considered.

**Future Research and/or Investigation.** Most good investigations raise additional questions that can not be addressed without additional time, talent and resources. The section should help focus the reader on what should be undertaken next.

**References Cited.** Please refer to the American Chemical Society guideline for the format that should be used and the manner in which references are cited (http://pubs.acs.org/userimages/ContentEditor/1246030496632/chapter14.pdf).

10 to 15 pages of text, excluding references, tables and figures, is a good target for the paper. I expect you to use the basic principles that we discuss in class: 12 green engineering principles in your recommendations, LCA, material flow analysis. Also, I expect you to examine sustainability metrics.
## 5. Course Content

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Content</th>
<th>Recommended Readings (readings would be posted on T-Square)</th>
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• Sustainability and Engineering in New Zealand: Practical Guidelines for Engineers.  
<p>| 2    | 1–Sep   | Geoengineering: Carbon Cycle          |                                                             |</p>
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| 3    | 6-Sep| Geoengineering: Other Natural Cycles | • Kauppi, P; Sedjo, R; Technological and Economic Potential of Options to Enhance, Maintain, and Manage Biological Carbon Reservoirs and Geoengineering, Chapter 4, *Climate Change 2001: Mitigation, IPCC Third Assessment Report*, 2001, 301–344  
<p>| 5    | 15-Sep| LCA Example on Water Treatment Technologies |</p>
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<tr>
<td>8</td>
<td>27-Sep</td>
<td>Grand Challenges continued: Technology Solutions</td>
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| 7    | 29-Sep | Risk Assessment: Target Plots, Pollution Prevention Assessment Framework, QSAR Model, Relative Risk Indices | US EPA. *Pollution Prevention (P2) Framework*; 2005  
| 9    | 4-Oct | Risk Assessment: Comparison of Two Industry Sectors, Reaction Pathway Selection | |
• The President’s Council on Sustainable Development. *Towards a Sustainable America*; 1999. |
<p>| 9    | 11-Oct | No Class. Student Recess | |
| 9    | 13-Oct | Mid-term Examination | |</p>
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<td></td>
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<td>• Macy, M. W; Willer, R; From Factors to Actors: Computational Sociology and Agent–Based Modeling. <em>Annual Review of Sociology.</em> 2002, 28, 143–166</td>
</tr>
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|      | 22–Nov | Legal and Political Realm of Sustainability, Business Models for Sustainability, Role of Engineers | • Viljoen, J; Defining a business model for sustainability – does one size fit all? 2008. *World Export Development Forum*  
• Papadakis, K; Socially sustainable development and participatory governance: legal and political aspects, 2006, International Institute for Labour Studies Geneva  
• Hart, S. L; Milstein, M. B; Global Sustainability and the Creative Destruction of Industries, *Sloan Management Review*, 1999 (Fall), 23–33 |
| 16   | 24–Nov | No Class. Thanksgiving Holiday             |                                                                                                                            |
|      | 29–Nov | Final Group Project Presentation           |                                                                                                                            |
| 17   | 1–Dec  | Final Group Project Presentation           |                                                                                                                            |
|      | 6–Dec  | No Class. Prepare for Project Report       |                                                                                                                            |
6. Useful Links

UN website:
http://www.unep.org/ (UN Division of Sustainable Development)
(UN Environment Programme)

Indicators:
http://www.epa.gov/indicate/ (US EPA)
http://www.iisd.org/measure/ (International Institute for Sustainable Development)
http://themes.eea.eu.int/all_indicators_box (European Union)
http://themes.eea.eu.int/index_html#Sectors_and_activities (European Union)
http://www.sustainable-development.gov.uk/indicators/index.htm (United Kingdom)
http://www.epa.gov/iwi/ (Watersheds)
http://www.epa.gov/ost/biocriteria/index.html (Biocriteria)
http://www.worldbank.org/data/wdi2001/ (World Development Indicators)
http://www.met-office.gov.uk/research/hadleycentre/ (Climate Prediction & Research)

Construction:
http://www.rethinkingconstruction.org/ (Constructing Excellence)
http://www.cbpp.org.uk/ (Best Practices)
http://www.m4i.org.uk (Movement for Innovation)
http://www.ciria.org.uk/ (Indicators)

Waste:
http://www.epa.gov/osw/ (US EPA)
http://ewasteguide.info/ (Electronic Wastes)

Energy:
http://www.esource.com/public/default.asp (Energy Business Intelligence)
http://www.eren.doe.gov/ (Renewable Energy)
http://www.cee1.org/home.html (Consortium of Energy Efficiency)
**LCA:**
http://iac.rutgers.edu/database/ (14,000+ Assessment)
http://hpb-1a.nrel.gov/lci/ (US LCI database)
http://www.epa.gov/nrmrl/lcaccess/ (US EPA)
http://www.life-cycle.org/ (LCA Links)
http://www.eiolca.net/ (CMU EIOlCA)

**Listing of World Wide Environmental Agencies / NGO's:**
http://gemi.org/ (Global Environnemntal Management Initiative)
http://www.sustainablebusiness.com/ (Sustainable Business)
http://www.wbcsd.org/ (World Business Council on Sustainable Development)
http://www.ceres.org/ (Coalition for Environmentally Responsible Economies)
http://www.globalreporting.org/ (Global Reporting Initiative)
http://www.ulsf.org/ (University Leaders for a Sustainable Future)
http://www.sdcn.org/ (Sustainable Development Communications Network)
http://www.environmentalsustainability.info/ (Environment Portal & Search Engine)
http://www.secondnature.org/ (Second Nature - Sustainable Education)
http://www.sustainableliving.org/ (Sustainable Living Network)
http://www.ucsusa.org/ (Union of Concerned Scientists)

http://www.epa.gov/oppt/greenengineering/ (The Green Engineering Program)
http://www.epa.gov/dfp/ (Designing for Environment Program)
http://www.epa.gov/cpg/ (Comprehensive Procurement Guidelines Program)
http://www.epa.gov/sectors/ (The Industry Partners Program)
http://www.epa.gov/epaoswer/hazwaste/minimize/ (The P2 Program)
http://www.epa.gov/epaoswer/non–hw/reduce/epr/ (The Product Stewardship Program)
Sustainability-related Journals:
http://pubs.acs.org/journal/esthaq (Environmental Science & Technology)
http://www.elsevier.com/locate/jclepro (Journal of Cleaner Production)
http://www.elsevier.com/locate/ecoolecon (Ecological Economics)
http://www.elsevier.com/locate/energy (Energy)
http://www.elsevier.com/locate/enpol (Energy Policy)
http://www.elsevier.com/locate/jenvman (Journal of Environmental Management)
http://www.springerlink.com/content/100370 (Environmental Management)
http://www.springerlink.com/content/120154 (Sustainability Science)
http://www.elsevier.com/locate/resconrec (Resources, Conservation and Recycling)