Materials 4I03 - Sustainable Manufacturing Processes

Fall 2019

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Office hours: Fridays 10am-12pm, or by appointment

Lectures: Wednesdays, 4:30pm-5:20pm, TSH B106
Mondays 3:30pm-5:20pm, TSH B106

Tutorials: Mondays, 9:30am-10:20am, TSH B106

Prerequisite:
Registration in the final or penultimate year of any Materials Engineering program or permission of instructor or enrollment in Level IV or above in other Engineering

Important Note:
The course management system will be Avenue to Learn. The student is required to check the system daily for assignment release/submission, course-related material, and posted announcements.

Course Description:
Participants in the course will acquire an in-depth understanding of issues associated with sustainable manufacturing processes. During the term, the course will discuss the following topics: Sustainable development, materials cycles, methods for measuring environmental impact, life cycle analysis including recycling, and stakeholder concept. Readings include articles written by leading scholars in the field of sustainability. This course will be organized in weekly lectures and discussions.

Learning Outcomes:
By the end of this course, students should be able to:
1. Define introductory and fundamental concepts of sustainability
2. Calculate personal ecological footprint.
3. Develop a life cycle analysis of an industry, a material or a process including compiling relevant data, calculation of material intensity (MI), energy intensity (EI), global warming potential (GWP) and acidification potential (AP).
4. Make a recommendation, including the justification for the most “sustainable” method of processing that could be used to process or produce a given object or material, discussing the merits and drawbacks of the processing steps in terms of at least three of the most significant sustainability measures.
5. Be able to identify stakeholders in engineering activities related to economic, environmental, and social factors, including a broad range of cultural and social backgrounds, both in Canada and abroad.

Graduate Attributes:
This course provides the student with an opportunity to develop competence in the following CEAB graduate attributes.

<table>
<thead>
<tr>
<th>Graduate Attributes</th>
<th>Learning Outcome Measuring Point</th>
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<tr>
<td>Impact (9.1 Identifies and quantifies the full range of short-term, long-term, local and global impacts of their engineering projects on society, including: economic aspects; social, cultural, and human health aspects, and; ecosystem integrity aspects.)</td>
<td>2, 4</td>
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<td>Impact (9.2 Addresses uncertainties in the prediction of interactions on society and the environment in a structured and transparent manner)</td>
<td>1, 5</td>
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<tr>
<td>Impact (9.3 Assesses possible options and design configurations from a sustainability engineering perspective, which emphasizes environmental stewardship, life-cycle analysis, and long-term decision-making principles.)</td>
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Text:
The custom courseware package is available at the McMaster Bookstore.

Assessment:

Individual Assignments: 20% (5% each)
The assignments must be submitted to the teaching assistant in the tutorial. If there is no tutorial at that particular week, please submit your assignments to course dropbox, JHE-213 one week after they are assigned.

Team Project: 40%
Prepare a 20-page (double-spaced, including Figures and Tables) report on sustainable manufacturing for industry, process, or product. Make a recommendation, with justification, of the most viable method(s), including at least three sustainability measures. The report must include an LCA that compares at least two competing processes, discuss the results, and add a sensitivity analysis for the relevant aspects of the LCA.

Data for the LCA can be taken from the literature, but the calculation and the analysis must be done with the methodology described in the lectures. Commercial software may
not be used for the calculation. The hard copy of the LCA report must be submitted to the course dropbox, JHE-213 by 5 pm on Dec 2.

Students are to form teams of 4 people of their choosing. Each student will submit 3 Peer Reviews. These reviews will rank and justify, if necessary, their contributions, as well as those from each group member to determine what fraction of the total mark each member shall receive. Weighting will be applied to 100% of the project mark. Each student needs to use the Excel file available on the avenue website. Peer evaluations will only be accepted if they are submitted within 3 days/72 hours of the relevant due date.

**In-class tests: 35%**
There will be two in-class tests throughout the term. They will deal with the knowledge of sustainability issues, methodology, and terminology.
In-class test 1: 15%
In-class test 2: 20%

**Participation: 5%**
The class participation through the term, including guest lectures using i-clicker and avenue website. However, each student will be permitted to miss up to three lectures and one guest lectures without a penalty.

**Policy on Written Work and Late Submissions:**
All written work will be marked on content and analysis as well as grammar, clarity of writing, and organization. More details about the marking scheme are posted on the course website. Late submissions will be penalized 20% per day. Late penalties will not be waived unless your Faculty/Program Office advises the instructor that you have submitted to that office the appropriate documentation to support your inability to provide the work by the due date.

**Schedule of topics and required readings:**
Sep. 4, Introduction/Outline
The handout is posted on the website.
Sep. 9, Population & Environment
*Living Planet Reports, 2016, 2014* are available at the World Wildlife Fund website:


Ingenuity Gap
*The Ingenuity Gap*, Homer-Dixon, T.
Sep. 11, Eco-Efficiency (Part A)
DeSimone, L.D., et al.
Eco-Efficiency: The Business Link to Sustainable Development.
Copyright (C) 2000 ** MIT Press

Sep. 16, Eco-Efficiency (Part B)
The Materials Cycle
"Foundations of Sustainable Resource Processing"
Herbertson, J. & Sutton, P.
Green Processing Conference, Cairns, Qld, 29-31 May 2002
Copyright (C) 2002 Unsourceable

Global Materials Flows in Minerals Processing"
Algie, S.H.
Green Processing Conference, Cairns, Qld, 29-31 May 2002
Copyright (C) 2002 Unsourceable

Sep. 18, Environmental Impact Metrics
“2012 The Outlook for Energy: A View to 2040”, ExxonMobil
“Industrial Energy Intensity by Industry,” Natural Resource Canada, 2004
“US Material Use factsheets,” Center for Sustainable Systems, October 2014
“Greenhouse Gasses and Global Warming Potential Values except for the
Inventory of U.S. greenhouse emissions and sinks,” U.S. Environmental
Protection Agency, 2002
Lenntech Water treatment & air purification Holding B.V., Netherlands

Sep. 23, The Role of Materials in Sustainable Development
Norgate, T.E. & Rankin, W.J.
Green Processing Conference, Cairns, Qld, 29-31 May 2002
Copyright (C) 2002 Reprinted with permission

Sep. 25, Introduction to LCA
Environmental Assessment of products, Weidema B.P.
1997 TEK-Finnish Assoc. Grad. Eng
Chapter 1. Life Cycle Assessment in a Historical Perspective
Chapter 2. The Application area for Life Cycle Assessments
Chapter 3. Life Cycle Assessment in Relation to Other Tools
Chapter 4. Life Cycle Management
Chapter 5. LCA to Z- A beginners Guide

Sep. 30, Computational Structure of LCA I
   Ch. 2 Basic Model for Inventory Analysis
   Ch. 3 The Refined Model for Inventory Analysis

Oct. 2, Computational Structure of LCA II
   Ch. 3 The Refined Model for Inventory Analysis

Oct. 7, In-class test 1

Oct. 9, Computational Structure of LCA III
   Ch. 3 The Refined Model for Inventory Analysis

Oct. 14-18, No class

Oct. 21, Open Loop Recycling in LCA
   "The value of Recycling to Society and its Internalization into LCA methodology"

Oct. 23, LCA Case Study – Pb & Zn Production
   "An Environmental Assessment of Lead and Zinc Production Processes"
   Norgate, T.E. & Rankin, W.J.
   Green Processing Conference, Cairns, Qld, 29-31 May 2002
   Copyright (C) 2002 Unsourceable

Oct. 28, Stakeholders

   LCA Case Study II

Oct. 30, Strategic Sustainable Development
   "Factor X for Subtle Policy Making"
   Robert, K-H., et al
   Copyright (C) 2000 Greenleaf Publishing Ltd.

   "Tools and Concepts for Sustainable Development, How Do They Relate..."
   Robert, K.-H.
Nov 7-Dec 1, Guest lecturers from Industry

Nov 18, In-class test 2

At certain points in the course it may make good sense to modify the schedule. For example, there could be changes in the schedule depending on the availability of guest lecturers. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website). Further, handouts for guest lectures will be posted on the website.

**Academic Integrity:**

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at www.mcmaster.ca/academicintegrity.

The following illustrates only three forms of academic dishonesty:

- Plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
- Improper collaboration in group work.
- Copying or using unauthorized aids in tests and examinations.

**Authenticity/plagiarism detection language:**

In this course the students are recommended to use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. Students will be expected to submit their work electronically via Avenue to Learn (A2L) plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish to submit their work through A2L must still submit an electronic and/or hardcopy to the instructor. No penalty will be assigned to a student who does not submit work to A2L. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). To see the Turnitin.com Policy, please go to www.mcmaster.ca/academicintegrity.
**Academic Accommodation of Students with Disabilities:**
Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information, consult McMaster University’s Academic Accommodation of Students with Disabilities policy.

**Academic Accommodation for religious, indigenous, or spiritual observances (RISO):**
Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

**Requests for relief for missed academic term work:**
McMaster Student Absence Form (MSAF)
In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

If you need to use MSAF for any assignment or in-class tests, you will be required to write a make-up exam, or you will be given a new assignment within 72 hours. Please directly communicate with the Associate Dean’s Office if you need further accommodation.

**Extreme circumstances:**
The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.