Materials 4I03 - Sustainable Manufacturing Processes

Fall 2021

Instructor: Dr. Muhammad Nabeel
Email: nabeelm@mcmaster.ca
Office hours: Tuesdays 11:00am-01:00pm, or by appointment

Mode of instruction: Online lectures via Microsoft Teams (recordings of virtual sessions will be available on Avenue for online access) and In-Person tutorials.

Synchronous Lectures: Mondays, 02:30pm-04:20pm, Wednesdays 02:30pm-03:20pm

In-Person Tutorials: Fridays, 10:30am-11:20am

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 students are 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.

Graduate Attributes	Learning Outcome Measuring Point
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.)	2, 4
Impact (9.2 Addresses uncertainties in the prediction of interactions on society and the environment in a structured and transparent manner)	1, 5
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.)	3

Text:

The custom courseware package is available at the McMaster Bookstore.

Assessment:

Individual Assignments: 20% (5% each)

The assignments must be submitted through Avenue within 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.

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.

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

Participation: 5%
The class participation will be assessed by short quizzes related to each lecture, including guest lectures. 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. 8, Introduction/Outline
The handout on Avenue and MS Teams.

Sep. 13, Population & Environment
Living Planet Reports, 2018, 2016, and 2014 are available at the World Wildlife Fund website:

http://www.worldwildlife.org/pages/living-planet-report-2014

https://wwf.panda.org/wwf_news/?282370/Living-Planet-Report-2016

http://www.wwf.ca/about_us/living_planet_2018/

Ingenuity Gap
The Ingenuity Gap, Homer-Dixon, T.
Copyright (C) 2001 Vintage Books Canada

Ch. 1 "Careening into the Future"
Ch. 9 "Ingenuity and Wealth"

Sep. 15, Eco-Efficiency (Part A)
DeSimone, L.D., et al.
Eco-Efficiency: The Business Link to Sustainable Development,
Copyright (C) 2000 ** MIT Press

Sep. 20, 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. 22, Environmental Impact Metrics
"2018 The Outlook for Energy: A View to 2040", ExxonMobil
"CSS05-18.pdf US Materials Use factsheet" Center for Sustainable Systems, 2018
"The Inventory of U.S. greenhouse emissions and sinks," U.S. Environmental Protection Agency, 2018
"Technical Summary in Climate Change" Copyright © The Intergovernmental Panel on Climate Change, 2013
"Summary for Policymakers" Copyright © The Intergovernmental Panel on Climate Change, 2013

Sep. 27, 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. 29, Introduction to LCA
Environmental Assessment of products, Weidema B.P.
1997 TEK-Finnish Assoc. Grad. Eng
Chapter 2. The Application area for Life Cycle Assessments
Chapter 3. Life Cycle Assessment in Relation to Other Tools

Oct. 4, Computational Structure of LCA I
Heijungs R. & Suh S, 2002, Luwer Academic Publishers
Ch. 2 Basic Model for Inventory Analysis

Oct. 6, Online test 1

Oct. 11-17, No class

Oct. 18, Computational Structure of LCA II
Heijungs R. & Suh S, 2002, Luwer Academic Publishers
Ch. 3 The Refined Model for Inventory Analysis

Oct. 20, Computational Structure of LCA III
Heijungs R. & Suh S, 2002, Luwer Academic Publishers
Ch. 3 The Refined Model for Inventory Analysis

Oct. 25, Open Loop Recycling in LCA
"The value of Recycling to Society and its Internalization into LCA methodology
J.P. Birat, La Revue de Metallurgie, 103, 2, 2006, Cambridge University Press US

Oct. 27, 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

Nov. 1, Stakeholders
Stakeholder Politics, Social Capital, Sustainable Development and the Corporation, Robert Boutilier, 2009, Greenleaf Publishing, available in pdf format for ~$45.00 from http://www.greenleaf-publishing.com or at Amazon for $20

LCA Case Study II

Nov. 3, Strategic Sustainable Development
"Tools and Concepts for Sustainable Development, How Do They Relate..."
Robert, K.-H.
Journal of Cleaner Production, Vol.8, 2000
Copyright (C) 2000 Elsevier Science

Nov. 8-Dec 8, Guest lecturers from Industry

Nov. 26, Online 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. **It is your responsibility to understand what constitutes academic dishonesty.**

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. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/

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

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection so ftware must inform the Inst ruct or before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-

line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/ software during tests or exams. This software may be required to be installed before the test/exam begins.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas.mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

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".

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 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.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

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.