



# ENGG\*4070 Life Cycle Assessment for Sustainable Design

01

Winter 2022

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - January 09, 2022

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## 1 Course Details

### 1.1 Calendar Description

This course will introduce students to the fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society. Students will understand the concepts and the scientific method as it applies to a systems-based, transdisciplinary approach to sustainability, and will be prepared to identify problems in sustainability and formulate appropriate solutions based on scientific research, applied science, social and economic issues. The basic concepts of life cycle assessment (LCA) will be discussed, along with life cycle inventory (LCI) and life cycle impact assessment (LCIA) including the social and economic dimensions. The application of life cycle assessment methodology using appropriate case studies will be presented.

**Pre-Requisites:** ENGG\*2100, ENGG\*3240

### 1.2 Course Description

This course aims to build an environmental management and life cycle thinking and techniques in support of advancing sustainable designs.

### 1.3 Timetable

**Lectures:** ROZH Room 106 for the face-to-face lectures when they resume in Week 3.

Tuesday and Thursday      11:30 AM– Room Virtual  
 1:50 PM      (first two weeks)

**Tutorials & Labs:** THRN Room 1313 for the face-to-face tutorials/labs when they resume in Week 3.

Monday      3:30 - 5:20      Room Virtual  
 PM      (first two weeks)

## 1.4 Final Exam

In class/Take Home Exam

Date: April 22, 2022 11:30 AM - 01:30 PM; Room TBA

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## 2 Instructional Support

### 2.1 Instructional Support Team

**Instructor:** Poritosh Roy  
**Email:** poritosh@uoguelph.ca  
**Telephone:** 2265001797  
**Office:** THRN 2361  
**Office Hours:** Tuesday (10:00-11:00 AM); Thursdays (2:00 PM to 4:00 PM) and by appointment

### 2.2 Teaching Assistants

**Teaching Assistant (GTA):** Akul Bhatt  
**Email:** akul@uoguelph.ca  
**Office Hours:** TBD

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## 3 Learning Resources

The lectures, labs and tutorials are the primary means used to support your learning in this course. Lectures will be the primary means for course news and announcements in addition to provision of course materials. Lecture attendance is expected. Tutorials will be the primary means for the instructional team to coach you. Tutorial attendance is expected. Labs will be

the primary means for some hands-on experience. Lab attendance is required.

### 3.1 Required Resources

#### Course Website (Website)

<https://courselink.uoguelph.ca/>

ENGG\*4070 Courselink site will provide copies of lecture slides, project descriptions, assignments, and links to additional resources.

#### Life Cycle Assessment: Quantitative Approaches for Decisions That Matter (Textbook)

(2018) H. Scott Matthews, Chris T. Hendrickson and Deanna H. Matthew (a pdf copy of this book will be posted in CourseLink)

#### Other Resources (Notes)

Will be posted on Courselink.

### 3.2 Recommended Resources

#### Sustainable Engineering: Concepts, Design & Case Studies (Textbook)

(2012) David T. Allen and David R. Shonnard. Prentice-Hall.

#### The Hitch Hiker's Guide to LCA (Textbook)

(2004) Henrikke Baumann and Anne-Marie Tillman. Studentlitterature.

#### Other Resources (Other)

Some additional suggestions will be posted on Courselink site.

### 3.3 Additional Resources

#### Lecture Information (Notes)

All the lecture slides will be posted on the Courselink site.

#### Lab Information (Notes)

Posted on Courselink.

#### Assignments (Notes)

Posted on Courselink.

#### Miscellaneous Information (Other)

See Courselink.

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## 4 Learning Outcomes

### 4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Understand the concept of a life cycle and its various stages
2. Apply appropriate skills for qualitative and quantitative analysis
3. Describe the types of costs that are included in a life cycle cost analysis

4. Describe the four major phases of the ISO LCA Standard
5. Perform an interpretation analysis and data acquisition for life cycle inventory analysis
6. Define, build, and use a process matrix LCA model
7. Select and justify Life Cycle Impact Assessment LCIA methods
8. Illustrate the value of life cycle techniques in the development of more sustainable designs
9. Demonstrate use of SimaPro and associated databases to support an LCA study

## 4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2, 3, 4, 6
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 2, 3, 4, 6
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1, 2, 3, 4, 6
4	Design	4, 5, 6
4.1	Describe design process used to develop design solution	4, 5, 6
4.4	Evaluate alternative design solutions based on problem definition	4
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	6
5	Use of Engineering Tools	2, 5, 6, 9
5.1	Select appropriate engineering tools from various alternatives	2, 9
5.2	Demonstrate proficiency in the application of selected engineering tools	5, 6, 9
7	Communication Skills	1, 2, 4, 6, 8
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	1, 2, 6, 8
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	2, 4
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	2

#	Outcome	Learning Outcome
9	Impact of Engineering on Society and the Environment	1, 2, 4, 6, 7
9.1	Analyze the safety, social, environmental, and legal aspects of engineering activity	1, 4, 6
9.2	Evaluate the uncertainties and risks associated with engineering activities	4, 7
9.3	Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems	2, 4, 7
11	Economics and Project Management	1, 3, 6
11.2	Identify risk and change management techniques, in the context of effective project management	1, 6
11.3	Estimate economic impact and feasibility of an engineering project or design using techniques such as cost benefit analysis over the life of the project or design	3, 6
12	Life Long Learning	6
12.3	Demonstrate capability for continuous knowledge and skill development in a changing world	6

### 4.3 Relationships with other Courses & Labs

**Previous Courses:**

**CHEM\*1040/1050:** The environmental side of life cycle techniques addresses inventories and impacts of elements and chemicals.

**ENGG\*1100/2100/3100:** Design skills including multi-objective decision making. Introduction to sustainable design concepts.

**ENGG\*3240:** Full Cost Accounting.

**Follow-on Courses:**

This is likely your final semester!

## 5 Teaching and Learning Activities

### 5.1 Lecture

**Week 1**

<b>Topics:</b>	Introduction, course outline, course expectation, Overview of LCA, Term Project [ <b>Jan 10-Jan 14</b> ]
<b>Learning Outcome:</b>	1
<b>Week 2</b>	
<b>Topics:</b>	Life Cycle Overview; ISO Standard, Assignment 1 (Due date: Jan 27) [ <b>Jan 17-Jan 21</b> ]
<b>Learning Outcome:</b>	1, 4
<b>Week 3</b>	
<b>Topics:</b>	Quantitative and Qualitative Methods, Supporting LCA; Formation of groups for term project, finalize the topics of term projects, Assignment 2 (Due date: Feb 2) [ <b>Jan 24-Jan 29</b> ]
	Outcome: 1, 2, 4, 6, 8
<b>Learning Outcome:</b>	2
<b>Week 4</b>	
<b>Topics:</b>	Quantitative and qualitative methods, Life cycle costing, Assignment 3 (Due date: February 9) [ <b>Jan 31-Feb 4</b> ]
	Outcome: 2,3
<b>Learning Outcome:</b>	3
<b>Week 5</b>	
<b>Topics:</b>	Life cycle costing/a case study, The ISO LCA Standard - Goal and Scope
	Assignment 4 (Due date: February 16) [ <b>Feb 7-Feb 11</b> ]
<b>Learning Outcome:</b>	4
<b>Week 6</b>	
<b>Topics:</b>	Data Acquisition and Management, Assignment 5 (Due date: March 2); Tutorial 1 (Due date: Feb 28) [ <b>Feb 14-Feb</b>

	<b>18]</b>
<b>Learning Outcome:</b>	5
<b>Week 7</b>	
<b>Topics:</b>	Multi-function system and LCA Model Process, Food LCA; Tutorial 2 (Due date: March 7) [ <b>Feb 28-March 4]</b>
<b>Learning Outcome:</b>	4, 6, 9
<b>Week 8</b>	
<b>Topics:</b>	Lightweighting/Biomaterial LCA, Economic Input-Output Models; Tutorial 3 (Due date: March 14) [ <b>March 7-March 11]</b>
<b>Learning Outcome:</b>	3
<b>Week 9</b>	
<b>Topics:</b>	Advanced Life Cycle Models, Consequential LCA (cLCA), Tutorial 4 (Due date: March 21) [ <b>March 14-March 18]</b>
<b>Learning Outcome:</b>	6, 7, 9
<b>Week 10</b>	
<b>Topics:</b>	Life Cycle Impact Assessment; Tutorial 5 (Due date: March 28) [ <b>March 21-March 25]</b>
<b>Learning Outcome:</b>	7, 8, 9
<b>Week 11</b>	
<b>Topics:</b>	Sensitivity analysis, Uncertainty Assessment in LCA [ <b>March 28-April 1]</b>
<b>Learning Outcome:</b>	7
<b>Week 12</b>	

**Topics:** Wrap-up, Course Evaluation; **[April 4-April 8]**

**Learning Outcome:** 8

## 5.2 Other Important Dates

Monday, January 10 2022: Classes commence

Monday, February 21 – Friday, February 25, 2022: Winter Break

Friday, April 8, 2022: Last date to drop courses

Friday, April 8, 2022: Classes conclude

Monday, April 25, 2022: Last date of the Semester

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# 6 Assessments

## 6.1 Marking Schemes & Distributions

### **Assignments\*\* (20%)**

A minimum of 4 assignments will be required.

### **Tutorials (20%)**

A minimum of 4 tutorials in SimaPro will be required

### **Term project\*\* (35%)**

Fri, Apr 8, 11:58 PM

The project report and PPT presentation is to be submitted



**Final exam (25%)**

Apr 22, 11:30 AM - 1:30 PM, TBD

**6.2 Assessment Details****Assignments and Tutorials\*\* (40%)**

**Learning Outcome:** 1, 2, 4, 5, 6, 7, 9

Minimum of 4 assignments and 4 tutorials will be required. The due date for each assignment will be one week after the posting on CourseLink. All assignments are individual works, so that no collaboration between the students is allowed.

**Term project\*\* (35%)**

**Due:** Fri, Apr 8, 11:58 PM

**Learning Outcome:** 1, 2, 4, 5, 7, 8, 9

**Project Schedule:**

**January 28:** Team release

**February 21:** Project proposals due. This includes group members, topic, draft objectives, and brief review of literature for existing studies, about three pages in length. **(5%)**

**March 1-4:** Possible Team meeting with instructor (online/in person) to discuss, revise and expand topic. Updates on objective, scope, functional unit, and methodology.

**April 7:** Voice-recorded ppt presentation due. **(8%)** if course become remote learning

**April 8:** Written report due. **(22%)**

***Electronic copies of both manuscript (MS-word) and presentation (PPT) are to be submitted via CourseLink Dropbox***

**Final exam April 22 (25%)**

**Date:** Fri, Apr 22, In class/Take Home Exam

**Learning Outcome:** 2, 3, 4, 5, 6, 7, 9

You will be given at least 72 hours to solve the exam after the posting (in the case of remote learning). The date of posting will be announced later.

**7 Course Statements****7.1 Course Grading Policies**

**Missed Assessments:** If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the

undergraduate calendar for information on regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

**Accommodation of Religious Obligations:** If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor **within two weeks of the start** of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

**Passing grade:** Students must obtain a grade of 50% or higher.

**Missed test:** If you miss a test due to grounds for granting academic consideration or religious accommodation then a deferred midterm will be scheduled at the earliest possible common date for all affected students.

**Late Reports:** Late submissions (without instructor permission based on suitable grounds and documentation) will be penalized.

## 8 School of Engineering Statements

### 8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

### 8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

### 8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

## 9 University Statements

### 9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

### 9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

### 9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

### 9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

## 9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website  
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website  
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct  
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct  
<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

## 9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

## 9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

## 9.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

## 9.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- <https://news.uoguelph.ca/return-to-campus/how-u-of-g-is-preparing-for-your-safe-return/>
- <https://news.uoguelph.ca/return-to-campus/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

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