



## ENGR 544 (3) Life Cycle Assessment and Management

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Lecture hours: in-person (**SCI-333**): Tuesday and Thursday (8:30 to 12:00).

Office hours: Tuesday (13:00 to 14:30) and Thursday (13:00 to 14:30).

### Academic Calendar Entry

#### **ENGR 544 (3) Life Cycle Assessment and Management**

Practical and theoretical applications of life cycle thinking in engineering projects, products, and processes. Understand international standards and methods in Life Cycle Assessment (LCA), Life Cycle Costing (LCC). Interpret and provide critical feedback on LCA/LCC studies and analyze claims on sustainability.

UBC Okanagan Academic Calendar: <http://www.calendar.ubc.ca/okanagan/>

### Course Format

- Two lectures per week.
- The student's performance will be assessed based on two group projects (including report and presentation), class practices, midterm, and final exam.
- Canvas will be used to distribute information such as course syllabus, case-study problems & solutions, lecture and tutorial notes, and announcements related to ENGR 544. To log in, please visit the webpage <https://canvas.ubc.ca> using your CWL Login ID and Password.

### Course Overview, Content, and Objectives

This course focuses on the important characteristics of life cycle assessment (LCA), theories and applications of life cycle thinking in engineering products and processes. The main objective of this course is to demonstrate the adoption of LCA-based approaches within policy-making, decision support systems and life cycle engineering and management. This course introduces methodologies and software (e.g., openLCA, CPLEX) required to analyze and optimize the sustainability (i.e., economic, environmental and social pillars) of product systems.

### Learning Outcomes

After completing this course, students will be able to:

- Understand the scope of LCA and Sustainability.
- Understand and practice the theory of LCA and Sustainability.
- Analyze the impact of production systems on environment.
- Design and optimize sustainable reverse logistics networks for real recycling plans.

**Engineering Accreditation**

The Canadian Engineering Accreditation Board requires students to have achieved competency in twelve main areas by graduation. To ensure that our program provides sufficient instruction in these 12 graduate attributes, course learning outcomes have been mapped to the graduate attributes for each course. The relevant graduate attributes for this course are identified below.

Course Learning Outcomes	Graduate Attributes (as defined below)											
	1	2	3	4	5	6	7	8	9	10	11	12
Understand the scope of LCA and Sustainability.	D											
Understand and practice the theory of LCA and Sustainability.							D					
Analyze the impact of production systems on environment.		D		A			A		D			
Design and optimize sustainable reverse logistics networks for real recycling plans.			D	A			A		D			

I = Introduced, D = Developed, A = Applied.

**CEAB Graduate Attributes**

**1. A knowledge base for engineering:** Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.

**2. Problem analysis:** An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.

**3. Investigation:** An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.

**4. Design:** An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.

**7. Communication skills:** An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.

**9. Impact of engineering on society and the environment:** An ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.

**Evaluation Criteria and Grading**

- Class Practices.....10%
- Midterm Exam.....20%
- Group Project 1.....15%
- Group Project 2.....15%
- Final Exam.....40%



### **Class Practices (10%)**

Some research questions will be given during the lecture, and answers should be uploaded in Canvas.

### **Midterm Exam (20%):**

Midterm exam will be held on **Jul. 18, 2024**. It will be closed-book and closed-note. The format of the midterm exam is still under development. There will be no make-up exam for the midterm. If one misses the midterm exam with a legitimate reason, his/her midterm weight of grade will be added to the final examination.

### **Group Project 1 (15%):**

Project 1 includes the application of **openLCA** to implement life cycle inventory analysis for a product system. The report of Project 1 must:

- Provide summaries of the product system (e.g., goal and scope definition and life cycle inventory analysis).
- Discuss and interpret the results of LCA to draw conclusions and insights.

The report must not exceed 20 pages in length (excluding title page and references), it should be double spaced, 2.54 cm margins all around, fonts (Times New Roman, size 12). Jul. 23, 2024 is the deadline to submit the report of Project 1 (Word or PDF) (10%). Every student is supposed to contribute to the PowerPoint slides for presenting Group Project 1. (5%).

### **Group Project 2 (15%):**

Project 2 includes the application of **CPLEX** to design and optimize sustainable reverse logistics networks for real recycling plans. The report of Project 2 must:

- Provide summaries of a recycling plan.
- Include the optimization model to design a sustainable reverse logistics network for the real recycling plan.
- Discuss the results to draw conclusions and insights.

The report must not exceed 20 pages in length (excluding title page and references), it should be double spaced, 2.54 cm margins all around, fonts (Times New Roman, size 12). Aug. 8, 2024 is the deadline to submit the report of Project 2 (Word or PDF) (10%). Every student is supposed to contribute to the PowerPoint slides for presenting Group Project 2. (5%).

### **Final Examination (40%):**

A three-hour **comprehensive** final examination will be held during the final exam period in August 2024. The exact date for the final examination will be determined and announced by the UBC. The final examination will be closed-book and closed-note. Detailed information on the final examination will be given to the students on the last day of class. The format of the final exam is still under development.

### **Required Readings**

- Lecture Notes.
- Hauschild, M. Z., Rosenbaum, R. K., & Olsen, S. I. (2018). Life cycle assessment (Vol. 2018). Springer International Publishing. <https://doi.org/10.1007/978-3-319-56475-3>.

**Recommended Software**

- OpenLCA,
- CPLEX

**Course Schedule**

The course schedule is subject to change and will be updated on a regular basis on Canvas.

Week	Date	Topic	Remarks
1	Tue., Jul. 2, 2024	Chapters 2 & 3: LCA characteristics and history Chapters 4 & 5: LCA applications and sustainability	Laptop is required
	Thu., Jul. 4, 2024	Chapter 7: Goal definition and openLCA software Chapter 8: Scope definition Chapter 9: Life cycle inventory analysis	Laptop is required
2	Tue., Jul. 9, 2024	Chapter 10: Life cycle impact assessment Chapter 12: Life cycle interpretation Chapter 14: Use of input-output analysis in LCA	
	Thu., Jul. 11, 2024	Application of openLCA software (lecture note)	Laptop is required
3	Tue., Jul. 16, 2024	Application of openLCA software (lecture note)	Laptop is required
	Thu., Jul. 18, 2024	Mid-term	Laptop is required
4	Tue., Jul. 23, 2024	Group Project 1 presentation (groups 1 to 15)	Project 1 deadline (Jul. 23, 2024)
	Thu., Jul. 25, 2024	CPLEX tutorial for mixed-integer linear programming	Laptop is required
5	Tue., Jul. 30, 2024	Life cycle engineering and management using CPLEX	Laptop is required
	Thu., Aug. 1, 2024	Chapter 15: Life cycle costing & Case study 2	Laptop is required
6	Tue., Aug. 6, 2024	Chapter 15: Life cycle costing	
	Thu., Aug. 8, 2024	Group Project 2 presentation (groups 1 to 15)	Project 2 deadline (Aug. 8, 2024)
	Aug. 12 to 16, 2024	<b>Exam Weeks</b>	

**Final Examinations**

Students are required to be available during the posted examination period to write the exam as scheduled. Except in the case of examination clashes and hardships (three or more formal examinations scheduled within a 24-hour period) or unforeseen events, students will be permitted to apply for out-of-time final examinations only if they are representing the University, the province, or the country in a competition or performance; serving in the Canadian military; observing a religious rite; working to support themselves or their family; or caring for a family member; or unforeseen events include (but may not be limited to) ill health or other personal challenges that arise during a term and changes in the requirements of an ongoing job. Further information on Academic Concession can be found under Policies and Regulation in the Okanagan Academic Calendar

[Academic Concession - Campus-wide Policies and Regulations - Okanagan Academic Calendar 2021/22 - UBC Student Services](http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0) - <http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0>

**Academic Integrity**

Academic and professional integrity are of the utmost importance at the School of Engineering. Online education can leave seemingly confusing implications for assignment and exam requirements. Please read your syllabus carefully to understand the expectations surrounding academic integrity in this course. In



addition, please familiarize yourself with the University of British Columbia's academic calendar language surrounding academic integrity for students:

*"The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences."*

A more detailed description of academic integrity, including the University's policies and procedures, may be found in the Academic Calendar at

[Discipline for Academic Misconduct - Student Conduct and Discipline - Campus-wide Policies and Regulations - Okanagan Academic Calendar 2021/22 - UBC Student Services -   
http://www.calendar.ubc.ca/okanagan/?tree=3,54,111,0](http://www.calendar.ubc.ca/okanagan/?tree=3,54,111,0)

In addition, all course material including lecture notes, assignments, and examination materials is the intellectual property of the instructor and as such must not be uploaded to third party, non-UBC sites for file sharing or for soliciting answers online. Doing so is considered academic misconduct under UBC's policies (see [Academic Misconduct - Discipline for Academic Misconduct - Student Conduct and Discipline - Campus-wide Policies and Regulations - Okanagan Academic Calendar 2021/22 - UBC Student Services -   
http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,54,111,959](http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,54,111,959)) including the following:

*"use of or participation in unauthorized collaborative work; use or possession in an examination of any materials (including devices) other than those permitted by the examiner; use, possession, or facilitation of unauthorized means to complete an examination (e.g., receiving unauthorized assistance from another person, or providing that assistance); and dishonest practices that breach rules governing examinations or submissions for academic evaluation see Student Conduct during Examinations)."*

Violating this is considered academic misconduct by the university and will be treated as such.

### *Assignments*

This course assesses student understanding of course material based on completed assignments. It is important to note that according to the UBC Okanagan Academic Calendar cheating includes the following:

*"falsification of any material subject to academic evaluation, including research data;"*

For example, in this course, this includes, but is not limited to, copying another student's work or allowing another student to copy your assignment. Students are expected to submit original work for their assignments in this course.

*"use of or participation in unauthorized collaborative work;"*



While collaboration is encouraged in some circumstances, not all collaboration is authorized. For example, in this course, unauthorized collaboration includes, but is not limited to, working in teams to complete projects that are intended as individual assessment.

### *Exams*

This course assesses student understanding of course material based on midterm and final examinations. It is important to note that according to the UBC Okanagan Academic Calendar cheating includes the following:

*“use or possession in an examination of any materials (including devices) other than those permitted by the examiner;”*

This includes, but is not limited to, possession during an exam of a cell phone, programmable calculator, or watch that is capable of storing unauthorized materials, unless specifically allowed.

*“use, possession, or facilitation of unauthorized means to complete an examination (e.g., receiving unauthorized assistance from another person, or providing that assistance);”*

This includes, but is not limited to, looking at another student’s exam paper during the examination time and accessing third-party online resources during exams unless explicitly permitted.

### *Plagiarism*

This course assesses student understanding of course material based on written reports. It is important to note that the UBC Okanagan Academic Calendar includes the following comprehensive description of plagiarism:

*“Plagiarism, which is intellectual theft, occurs when an individual submits or presents the oral or written work of another person as his or her own. Scholarship quite properly rests upon examining and referring to the thoughts and writings of others. However, when another person's words (i.e., phrases, sentences, or paragraphs), ideas, or entire works are used, the author must be acknowledged in the text, in footnotes, in endnotes, or in another accepted form of academic citation. Where direct quotations are made, they must be clearly delineated (e.g., within quotation marks or separately indented). Failure to provide proper attribution is plagiarism because it represents someone else's work as one's own. Plagiarism should not occur in submitted drafts or final works. A student who seeks assistance from a tutor or other scholastic aids must ensure that the work submitted is the student's own. Students are responsible for ensuring that any work submitted does not constitute plagiarism. Students who are in any doubt as to what constitutes plagiarism should consult their instructor before handing in any assignments.”*

Students are responsible for ensuring all work is original and source use is properly documented.

For additional language specific to online education, please consult the Academic Integrity Working Group’s website at

<https://provost.ok.ubc.ca/initiatives/online-transition/faculty-resources/faculty-resources-for-academic-integrity>

### **Academic Misconduct Procedures**

The following steps will be followed in cases of suspected academic misconduct:

- The instructor will notify the student of the alleged misconduct and the assigned penalty.
- The student may appeal by submitting a written statement to the instructor.



- The instructor will report the incident to the School of Engineering Academic Integrity Committee and will include the student's response.
- The Academic Misconduct Review Committee will review the case and either issue a warning letter to the student or recommend further review by the Executive Associate Dean.
- The Executive Associate Dean will meet with the student and either issue a warning letter or refer the matter to the President's Advisory Committee on Student Discipline (if applicable).
- The case will be heard by the President's Advisory Committee on Student Discipline (if applicable).

### **Grading Practices**

Faculties, departments, and schools reserve the right to scale grades in order to maintain equity among sections and conformity to University, faculty, department, or school norms. Students should therefore note that an unofficial grade given by an instructor might be changed by the faculty, department, or school. Grades are not official until they appear on a student's academic record. Further information on Grading Practices can be found in the Okanagan Academic Calendar  
<http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,41,90,1014>

### **Student Service Resources**

#### **UBC Okanagan Disability Resource Centre**

The Disability Resource Centre ensures educational equity for students with disabilities and chronic medical conditions. If you are disabled, have an injury or illness and require academic accommodations to meet the course objectives, please contact Jason Taylor, the Diversity Advisor for the School of Engineering in the Disability Resource Centre located in the University Centre building (UNC 214).

email: [jason.taylor@ubc.ca](mailto:jason.taylor@ubc.ca)

Web: [www.students.ok.ubc.ca/drc](http://www.students.ok.ubc.ca/drc)

#### **UBC Okanagan Equity and Inclusion Office**

Through leadership, vision, and collaborative action, the Equity & Inclusion Office (EIO) develops action strategies in support of efforts to embed equity and inclusion in the daily operations across the campus. The EIO provides education and training from cultivating respectful, inclusive spaces and communities to understanding unconscious/implicit bias and its operation within campus environments. UBC Policy 3 prohibits discrimination and harassment on the basis of BC's Human Rights Code. If you require assistance related to an issue of equity, educational programs, discrimination or harassment please contact the EIO.

UNC 216 (250.807.9291)

email: [equity.ubco@ubc.ca](mailto:equity.ubco@ubc.ca)

Web: [www.equity.ok.ubc.ca](http://www.equity.ok.ubc.ca)

### **Health & Wellness**

At UBC Okanagan health services to students are provided by Health and Wellness. Nurses, physicians and counsellors provide health care and counselling related to physical health, emotional/mental health and sexual/reproductive health concerns. As well, health promotion, education and research activities are provided to the campus community. If you require assistance with your health, please contact Health and Wellness for more information or to book an appointment.

UNC 337 (250.807.9270)

email: [healthwellness.okanagan@ubc.ca](mailto:healthwellness.okanagan@ubc.ca)





Web: [www.students.ok.ubc.ca/health-wellness](http://www.students.ok.ubc.ca/health-wellness)

### **Resource Links**

UBC Okanagan Academic Calendar: <http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,54,111,959>

UBC Okanagan Senate Forms: <https://senate.ubc.ca/okanagan/curriculum/forms>

UBC Okanagan Provost Learning Services Faculty Resources for Academic Integrity -

<https://provost.ok.ubc.ca/initiatives/online-transition/faculty-resources/faculty-resources-for-academic-integrity/>

### **SAFEWALK**

*Don't want to walk alone at night? Not too sure how to get somewhere on campus? Call Safewalk at  
**250-807-8076.***

*For more information, see: [www.security.ok.ubc.ca](http://www.security.ok.ubc.ca)*





**Academic Honesty and Integrity Pledge**  
**School of Engineering | Faculty of Applied Science**  
**UBC Okanagan**

Academic honesty and integrity are essential principles of the University of British Columbia and engineering as a profession. All UBC students are expected to behave as honest and responsible members of an academic community. Engineering students have an even greater responsibility to maintain the highest level of academic honesty and integrity as they prepare to enter a profession with those principles as a cornerstone.

Cheating on exams or projects, plagiarizing or any other form of academic dishonesty are clear violations of these principles

As a student of the School of Engineering at UBC Okanagan, I solemnly pledge to follow the policies, principles, rules, and guidelines of the University with respect to academic honesty. In particular, I commit to upholding the academic integrity and the professionalism as an engineering student.

By signing this pledge, I promise to adhere to exam requirements and maintain the highest level of ethical principles during the exam period.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Name

\_\_\_\_\_  
Student Number

\_\_\_\_\_  
Date