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|--|--|------------------|---------------------|
| Course Title: Life Cycle Assessment in Design | | | |
| Course Number | EVDS 683.85/ ENEN 693 H(2-1) | | |
| Pre/Co-Requisites | none | | |
| Instructor Name | Getachew Assefa | Instructor Email | gassefa@ucalgary.ca |
| Office Location | PF3191 | | |
| TA Name | | TA Email | |
| Class Dates | Fall 2019, Thursdays | | |
| Class Times | 9:00am to 12:10pm | | |
| Class Location | PF 2140 for lecture and PF 2170 for project activities | | |

Course Information / Description of the Course

Human activities are responsible for a number of environmental impacts at different levels. Many decisions made at the design stage determine impacts of the products, structures, services and business units that manifest during production, use and beyond. Assessment of such impacts can be best done using a life cycle perspective. The analytical tool of life cycle assessment (LCA) supports informed decision-making by avoiding problem-shifting and sub-optimization. When dealing with measures of improving environmental performance, problem-shifting occurs between life cycle stages e.g. upstream to downstream parts of the life cycle. It may also occur between medium such as shifting from air pollution to water pollution. Burden is also being shifted in space (e.g. from urban to rural) and in time (e.g. from today to the future). LCA provides an opportunity of, at least, minimizing such problem-shifting.

This course on LCA in design, offered for senior undergraduate and graduate students, helps would-be engineers, architects, designers and business professionals develop the skill of understanding the far-reaching and lasting implications of the decisions they make at different levels of product and service design and development.

The course delivery includes Lectures, LCA Review, Project, and Critique.

i) Lectures

The lectures will provide a theoretical background of LCA covering, among others, the following:

a) Methodological

- Identification and delimitation of the system boundary
- Defining and handling of allocation problems
- Midpoint and endpoint approaches

b) Data

- Identification and use of data from LCA databases
- Collection and use of data from other sources

c) Results reporting and application

- Contents of an LCA report
- Analysis and interpretation of LCA results

The lectures cover main topic areas of the course briefly outlined below.

Background to LCA

Reflecting on features of LCA including some brief history of LCA and different phases of LCA.

Goal and scope definition

The first phase of LCA includes aspects of system boundary, functional units, data quality requirements, etc.

Life cycle inventory analysis

Based on the information from the Goal and Scope Definition, quantitative dimension of LCA including data collection and modeling of the product or service system under consideration.

Life cycle impact assessment and Interpretations

The methods and approaches for quantifying the environmental impacts using the data collected; the implication of the choices involved in applying the different methods of aggregating data and weighting.

Data availability and quality in LCA

Data quality and associated issues will be outlined together with presentation of selected LCA software tools.

Product category rules and Environmental product declarations

Environmental product declarations as LCA -based labeling of products and services are the practical way of communicating the environmental performance through independently verified documents. How EPDs are developed based on product category rules will be explored and examples from different sectors will be provided.

Streamlined LCA and life cycle sustainability assessment

How life cycle thinking can be used without necessarily doing detailed quantitative LCA; and the expansion of environmental life cycle assessment to include the economic and social realm as part of a life cycle sustainability assessment will be covered.

ii) Exercises

Each lecture is followed by exercise questions that cover important parts of the lectures.

iii) Review (two group written submissions and video presentation)

Two reviews will be done in groups based on master thesis LCA studies. The task here is to **summarize** and **present** the **content** and **result** of the study in written form and **reflect** and **evaluate on weaknesses and strengths** of the study in a group video presentation.

For detail on how to approach the **Critical Review**, please refer to a separate file entitled **Instructions for Group Critical Review**.

iv) Project (four group submissions and presentations)

Students will utilize the knowledge from the course to get an insight into the opportunities and challenges of carrying out an LCA by performing a full LCA of an assigned product system from the list below. The significant parts of the deliverables are expected to be completed during the scheduled class time with support from the course administration. **OpenLCA** software will be used for the project.

Project topics:

- A solar and wind electricity supply for the Kluane Lake Research Station (KLRS)
- Electric car transport for an average Albertan
- A greenhouse in Alberta for growing vegetables heated by natural gas and biogas from the waste
- High speed train between Calgary and Edmonton
- A new high performance building at the University of Calgary
- A mobility network in the Northwest Territories

For detailed requirements and expectations on **the project**, see a separate **Instructions for Group Project**.

v) Critique (four individual written submissions)

For each of the group submissions of the four project activities, each student will write a critique on a group submission and presentation. Part of the submission is also marks assigned to the critiqued group's submission with motivation. See **Instructions for Individual Project Critique** for further information.

Learning Resources

Required readings, textbooks and learning materials:

There is no specific required textbook for the course. However, the following books are recommended for those interested in doing further readings.

Klöppfer, W. and Grah, B. (2014) Life Cycle Assessment (LCA): A Guide to Best Practice. John Wiley & Sons. (e-book through University of Calgary Library website)
<http://site.ebrary.com.ezproxy.lib.ucalgary.ca/lib/ucalgary/detail.action?docID=10855742>

Matthews, H. S., Hendrickson, C. T., & Matthews, D. H. (2015). Life cycle assessment: Quantitative approaches for decisions that matter. (e-book available for download for free at: <https://www.lcatextbook.com/>)

The LCA studies that will be used in the two review exercises will also add into the course resources.

Technology requirements (D2L etc.): D2L will be used as a course platform. For Life Cycle Software, **OpenLCA** (<http://www.openlca.org/>) will be used for the projects. Depending on the topic, **GREET 1** and **2** (<https://greet.es.anl.gov/greet.models>) as well as **GHGenius**

(<https://www.ghgenius.ca/>) can be used for retrieving part of the data required for the projects.

Course Learning Outcomes

After completing the course, students should be able to:

1. Understand the overall purpose and principles of LCA.
2. Describe the content and explain the purpose of the different steps of LCA.
3. Carry out a complete LCA of a defined system based on the ISO standard for LCA.
4. Write an LCA report complying with guidelines and terminologies of the ISO standard.
5. Discuss possible applications and limitations of LCA.
6. Understand how a third-party critical review of LCA is done.

Assessment Components

| Assessment Method | Description | Weight | Aligned Course Learning Outcome |
|-------------------|--|--------|---------------------------------|
| Group Assignment | Review 1 | 5 | 5 and 6 |
| | Review 2 | 5 | 5 and 6 |
| | Project Activity 1 | 5 | 1 |
| | Project Activity 2 | 10 | 2,3 and 4 |
| | Project Activity 3 | 5 | 2,3 and 4 |
| | Project Activity 4 | 10 | 2,3 and 4 |
| Individual | Critique (5 per each project activity) | 20 | 5 and 6 |
| Individual | Test 1 | 20 | 2,3 and 4 |
| Individual | Test 2 | 20 | 2,3 and 4 |

Assessment and Evaluation Information

Attendance and Participation Expectations: all students are expected to attend and participate in the project activities as groups and perform the critiques individually. All group members are expected to participate in the group work and each member's specific contribution should be clearly documented.

Guidelines for Submitting Assignments: assignment should be submitted through D2L Dropbox before midnight of the deadline date.

Final Examinations: There is no final examination. The two tests make up 40% of the overall evaluation of the course.

Expectations for Writing (<https://www.ucalgary.ca/pubs/calendar/current/e-2.html>): written submissions should have a clear structure using headings, citation of sources when appropriate, written in single spaced 12pts times new roman or equivalents (for Word document submissions) and clearly show the names of group members.

Late Assignments: 1 mark per day late will be deducted for each late submission of assignment.

Criteria that must be met to pass: there is no specific component that will be used as a criteria. It is the overall performance that will determine the final score.

Final grades will be reported as letter grades, with correspondence between letter grades, 4-points scale and percent based on the following grading scale.

| Grading Scale | | | | |
|---------------|-------------------|---------------|----------|---|
| Grade | Grade Point Value | 4-Point Range | Percent | Description |
| A+ | 4.00 | 4.00 | 95-100 | Outstanding - evaluated by instructor |
| A | 4.00 | 3.85-4.00 | 90-94.99 | Excellent - superior performance showing comprehensive understanding of the subject matter |
| A- | 3.70 | 3.50-3.84 | 85-89.99 | Very good performance |
| B+ | 3.30 | 3.15-3.49 | 80-84.99 | Good performance |
| B | 3.00 | 2.85-3.14 | 75-79.99 | Satisfactory performance |
| B- | 2.70 | 2.50-2.84 | 70-74.99 | Minimum pass for students in the Faculty of Graduate Studies |
| C+ | 2.30 | 2.15-2.49 | 65-69.99 | All final grades below B- are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements. |
| C | 2.00 | 1.85-2.14 | 60-64.99 | |
| C- | 1.70 | 1.50-1.84 | 55-59.99 | |
| D+ | 1.30 | 1.15-1.49 | 50-54.99 | |
| D | 1.00 | 0.50-1.14 | 45-49.99 | |
| F | 0.00 | 0-0.49 | 0-44.99 | |

A student who receives a "C+" or lower in any one course will be required to withdraw regardless of their grade point average (GPA) unless the program recommends otherwise. If the program permits the student to retake a failed course, the second grade will replace the initial grade in the calculation of the GPA, and both grades will appear on the transcript.

| Topic Areas & Detailed Class Schedule | | |
|---------------------------------------|--|--|
| Course Schedule Date | Topic | Assignments/Due Dates |
| September 5 | Lecture 1 – Full LCA Overview | |
| | OpenLCA – Introduction | |
| September 12 | Lecture 2 – Data and Methodological Aspects | |
| | Project Activity 1 | |
| September 19 | Lecture 3 – PCRs and EPDs | |
| | Project Activity 1 | |
| September 26 | Lecture 4 – Streamlined LCA and Life cycle sustainability assessment | Review 1 submission – written (summary) and video (weaknesses and strengths) |
| | Project Activity 2 | |
| October 1 | | Project Activity 1 submission |
| October 3 | Project Activity 1 Presentation | Review 2 submission - written (summary) and video (weaknesses and strengths) |
| | Project Activity 2 | |
| October 10 | Guest Lecture 1 | |
| | Project Activity 2/3 | |
| October 15 | | Submission of Critique on Project Activity 1 |
| October 17 | Project Activity 2 Presentation | Project Activity 2 submission |
| | Project Activity 3 | |
| October 24 | No classes / SAPL Block Week | |
| October 31 | Test 1 | |
| | Project Activity 3 | |
| November 7 | Guest Lecture 2 | Submission of Critique on Project Activity 2 |
| | Project Activity 3 | |
| November 14 | No classes – term break | |
| November 19 | | Project Activity 3 submission |
| November 21 | Project Activity 3 Presentation | |
| | Project Activity 4 | |
| November 28 | Test 2 | Submission of Critique on Project Activity 3 |
| | Project Activity 4 | |
| December 3 | | Project Activity 4 submission |
| December 5 | Project 4 Activity and Final presentation | |
| December 6 | | Submission of Critique on Project Activity 4 |

Media and Recording in Learning Environments

Part 1

University Calendar: <https://www.ucalgary.ca/pubs/calendar/current/e-6.html>

Recording of lectures (other than audio recordings that are pre-arranged as part of an authorized accommodation) is not permitted.

Students may not record any portion of a lecture, class discussion or course-related learning activity without the prior and explicit written permission of the course instructor or authorization from Student Accessibility Services. For any other use, whether by duplication, transcription, publication, sale or transfer of recordings, written approval must be obtained from the instructor for the specific use proposed. Any use other than that described above constitutes academic misconduct and may result in suspension or expulsion.

Part 2

The instructor may use media recordings to capture the delivery of a lecture.

The instructor will notify all students and guests in the class that the event is being recorded. If a student or guest wants to take steps to protect privacy, and does not want to be recorded, the instructor will provide the individual (s) with an alternative means of participating and asking questions (e.g., passing written notes with questions). Students cannot be penalized for choosing not to be recorded in situations where participation is part of the course. Students must be offered other ways of earning participation credit that do not involve recording.

Any video-recording would be intended to only capture the instructor and the front of the classroom. Students/other participants would not necessarily be visible on video recordings.

University of Calgary Policies and Supports

ACADEMIC ACCOMMODATION

Students seeking an accommodation based on disability or medical concerns should contact Student Accessibility Services; SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/. Students who require an accommodation in relation to their coursework based on a protected ground other than disability should communicate this need in writing to their Instructor.

The full policy on Student Accommodations is available at

<http://www.ucalgary.ca/policies/files/policies/student-accommodation-policy.pdf>.

ACADEMIC MISCONDUCT

Plagiarism involves submitting or presenting work in a course as if it were the student's own work done expressly for that particular course when, in fact, it is not. Most commonly plagiarism exists when: (a) the work submitted or presented was done, in whole or in part, by an individual other than the one submitting or presenting the work, (b) parts of the work are taken from another source without reference to the original author, (c) the whole work (e.g., an essay) is copied from another source, and/or, (d) a student submits or presents work in one course which has also been submitted in another course (although it may be completely original with that student) without the knowledge of or prior agreement of the instructor involved. While it is recognized that scholarly work often involves reference to the ideas, data and conclusions of other scholars, intellectual honesty requires that such

references be explicitly and clearly noted. Plagiarism is an extremely serious academic offence. Any suspicion of plagiarism will be reported to the Dean, and dealt with as per the regulations in the University of Calgary Graduate Calendar.

For information on academic misconduct and its consequences, please see the University of Calgary Calendar at <http://www.ucalgary.ca/pubs/calendar/current/k.html>

COPYRIGHT LEGISLATION:

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (www.ucalgary.ca/policies/files/policies/acceptable-use-of-material-protected-by-copyright.pdf) and requirements of the copyright act (<https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html>) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy.

FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary.

UNIVERSITY STUDENT APPEALS OFFICE: If a student has a concern about the course, academic matter, or a grade that they have been assigned, they must first communicate this concern with the instructor. If the concern cannot be resolved with the instructor, the student can proceed with an academic appeal, which normally begins with the Faculty. <https://ucalgary.ca/student-appeals/>

More student support and resources (e.g. safety and wellness) can be found here: <https://www.ucalgary.ca/registrar/registration/course-outlines>