



Code: ING-IND/09

Credits: 9

Matter: Life Cycle Thinking and Assessment

Main language of instruction: English

Other language of instruction: Italian

Teaching Staff

Head instructor

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Introduction

1. Objective of the course:

The course has the following educational objectives:

1. Introduce students to the approach of analysis of the entire life cycle of processes and products
2. Introduce students to the environmental assessment methodology Life Cycle Assessment (LCA)
3. Introduce students to the application of LCA
4. Introduce students to the methodologies of Social LCA and Life Cycle Costing

Objectives

2. Course Structure:

Module 1 - Introduction to the life cycle thinking and assessment

Module 2 - Application of life cycle assessment

Module 3 - Social life cycle assessment and costing

Competencies:

A. Knowledge and understanding.

Students will gain a basic understanding of the life cycle thinking and life cycle assessment (LCA) principles and processes, including the different components and stages of the life cycle. Become familiar with the methods and techniques used to conduct LCA and their application in the development and promotion of sustainable products and services. Develop an understanding of how LCA can be used in a business or engineering context, what kind of information it may provide, how it can

be useful. Students will gain a basic understanding of the of S-LCA and LCC. Develop an understanding of how S-LCA and LCC can be used in private/public context.

B. Applying knowledge and understanding.

Students will be able to apply LCA to products and services. Students will be able to apply S-LCA and LCC to different real-world scenarios of products and services life cycles.

C. Making judgements.

Students will be able to analyse the results of LCA in terms of environmental impacts of products and services. Critically evaluate the results of LCA; develop recommendations for improving the sustainability of products and services. Identify opportunities for reducing the environmental load of products and services using life cycle management and design for environment practices. Students will be able to analyse the results of S-LCA and LCC of products and services. Critically evaluate the results of S-LCA and LCC; develop recommendations for improving the sustainability of products and services.

D. Communication skills.

Development of a correct and comprehensible scientific language that allows to express in a clear and unambiguous way the knowledge acquired. Ability to illustrate and explain the contents of the existing case studies analysed (Modules 1, 3). Ability to illustrate and explain the results of the specific elaboration of a case study (Module 2).

E. Learning skills.

Capability of autonomously studying additional in-depth details related to the subject.

Syllabus

3. Programme of the course:

Module 1.

- Introduction and environmental assessments.
- Introduction to Life Cycle Thinking (LCT)
- Purposes and use cases of LCA (examples)
- Legal background
- Examples: everyday examples
- ISO 14040/44 Framework
- Goal and scope: definitions; terminology; examples
- Inventory: data and modelling; fore- and back-ground; multifunctional systems (system expansion etc.); commercial databases; examples

- Impact assessment: classification, characterization, normalisation and weighting; survey of different available methods – references to Environmental footprint
- Interpretation of results and Improvement
- Introduction to sensitivity and uncertainty analyses

Assignment 1.1: select an LCA-related scientific article and analyse it. Identify the phases according to the ISO 14040 framework; highlight i) the goal/purpose of the study; ii) the functional unit; iii) the system boundary; iv) types of data for the inventory and how in detail they are reported; v) the impact assessment method used; vi) how the results are reported and how they are analysed; whether improvements to the system are proposed and analysed; vii) whether a sensitivity analysis is performed; viii) whether an uncertainty analysis is performed. Reporting in a presentation.

Module 2.

- Recall of Life Cycle Thinking (LCT) and Life Cycle Sustainability and focus on LCA concepts
- Product Environmental Footprint (PEF) and Organisation Environmental Footprint (OEF); International Environmental Product Declaration (EPD)
- Training/Introduction on how to use Open LCA
- Carbon Footprint
- Water Footprint
- Methods for allocation
- Methods for sensitivity analysis
- Methods for uncertainty analysis

Assignment 2.1: a case study is assigned; students need to develop the LCA according to the ISO 14040 phases; they need to collect data for the inventory (companies/literature); perform the complete LCA; evaluate the robustness of their LCA through sensitivity and uncertainty analysis. Reporting in a presentation.

The case study is assigned at the very beginning of the course, so that students will work on it during the development of course and can interact with the teachers when needed.

Module 2.

- Recall of Life Cycle Sustainability
- The main S-LCA development in the last 10 years
- Introduction to the S-LCA and regulatory references that provide for the Social LCA versus LCA: similarities and differences
- Goal and scope of S-LCA
- Social Hotspot Analysis

- Database and data collection
- Training on how to use S-LCA software/databases
- Life Cycle Costing (LCC): definitions
- Methodologies and indicators
- Purchase price and all associated costs (delivery, installation, insurance, etc.)
- Operating costs, including energy, fuel and water use, spares, and maintenance
- End-of-life costs

Assignment 3.1:

Select a S-LCA-related scientific article and analyse it. Reporting in a presentation.

or

Assignment 3.2:

Select an LCC-related scientific article and analyse it. Reporting in a presentation.

Evaluation system and criteria

The exam consists of a written test - aimed at assessing the knowledge acquired and the ability to re-elaborate the concepts acquired - and assignments carried out during the course, aimed at assessing the ability to analyse and evaluate an existing case study (Module 1, 3) and to elaborate, analyse and evaluate one's own case study (Module 2).

For each module there will be an assignment and a final written exam, which will be assessed according to the following methods:

- Module 1: assignment: 12 points; final written exam: 18 points; total: 30
- Module 2: assignment: 24 points; final written exam: 6 points; total: 30
- Module 3: assignment: 12 points; final written exam: 18 points; total: 30

The completion of the assignment is carried out in progress. The delivery and preliminary discussion of the assignment is mandatory in order to take the written test.

The final exam, therefore, will consist of a written test, composed of three different sections, and is divided into the completion of exercises related to the types of exercises done during the exercises, and theoretical questions relating to the three modules. Each question/exercise is assigned a score, so that the method of formation of the final score assigned to the section relating to each module of the written test is clear.

The final grade will be calculated as the arithmetic mean of the grade obtained in each of the three modules attended and passed by each student.

The written exam will consist of 2 parts: Partial Test 1 and Partial Test 2.

Partial Test 1 will focus on topics from Modules 1 and 2

Partial Test 2 will focus on topics from Module 3.

The exam can be taken in the following ways:

- Full exam: in this case the exam will be taken in its entirety.
- Partial test: in this case it will be possible to take only the part (Partial Test 1) and then the second part (Partial Test 2).

In order to access the Partial Test 1, the student must have previously completed and discussed the assignments relating to Module 1 and Module 2.

In order to access the Partial Test 2, the student must have previously completed and discussed the assignment relating to Module 3.

In order to access the Full Exam, the student must have previously completed and discussed the assignments relating to Module 1, Module 2 and Module 3.

Bibliography and resources

4. Materials to consult:

Slides and teaching materials provided by the teacher.

5. Recommended bibliography:

- *Walter Klöpffer, Birgit Grahl. Life Cycle Assessment (LCA): A Guide to Best Practice. Wiley, 2014. ISBN: 978-3-527-32986-1*
- *Henrikke Bauman, Anne-Marie Tillm. The Hitch Hiker's Guide to LCA. Professional Pub Service, 2004. ISBN: 9144023642*