GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2026-2027

Sustainable Systems Engineering (I003060)

Course size *(nominal values; actual values may depend on programme)*

Credits 5.0 **Study time 150 h**

Course offerings in academic year 2026-2027

A (semester 1)	English	Gent

Lecturers in academic year 2026-2027

Huysveld, Sophie	LA24	lecturer-in-charge
Cadena Martinez, Erasmo	LA24	co-lecturer
Nachtergaele, Pieter	LA24	co-lecturer

Offered in the following programmes in 2026-2027	crdts	offering
Master of Science in Business Engineering(main subject Data Analytics)	5	A
Master of Science in Business Engineering(main subject Operations Management)	5	A
International Master of Science in Sustainable and Innovative Natural Resource Management	5	A
Master of Science in Biochemical Engineering Technology	5	A
Master of Science in Bioscience Engineering: Chemistry and Bioprocess Technology	5	A
Master of Science in Bioscience Engineering: Food Science and Nutrition	5	A
Master of Science in Chemical Engineering	5	A
Master of Science in Chemical Engineering	5	A
Master of Science in Food Technology	5	A
Master of Science in Pharmaceutical Engineering	5	A
Exchange Programme in Bioscience Engineering: Chemistry and Bioprocess Technology (master's level)	5	A
Exchange Programme in Bioscience Engineering: Environmental Technology (master's level)	5	A
Exchange Programme in Bioscience Engineering: Food Science and Nutrition (master's level)	5	A

Teaching languages

English

Keywords

sustainability, circular economy (metrics), process assessment metrics, process integration, exergy, material flow analysis, product design, life cycle thinking, life cycle sustainability assessment

Position of the course

This course focuses on the sustainability (assessment) of technological operations (human activities) and how to make them more sustainable from an environmental perspective in the first place, but also attention is paid to economic and social aspects. The lectures are divided into two main parts, i. Concepts for sustainable systems engineering, and ii. Sustainability assessment. On the one hand, relevant concepts and assessment methods are covered in a theoretical way. On the other hand, some methods (e.g. life cycle assessment, circular economy indicators, process integration, process assessment metrics, exergy) are also taught how to conduct them in a practical way.

Contents

Part Concepts for sustainable systems engineering

- Clean technology

- Ecosystem services
- Circular economy and related concepts (e.g. industrial ecology, industrial symbiosis)
- Life cycle sustainability (including Life Cycle Assessment (LCA), Life Cycle Costing (LCC), social LCA, etc.) and challenges
- Sustainbility in industrial production (process level), including exercises on heat integration

Part Sustainability Assessment

- Overview/introduction sustainability assessment methods
- Circular economy indicators
- Environmental Life Cycle Assessment (LCA), including a groupwork
- Process assessment metrics and exergy, including exercises

Initial competences

Students are expected to have a scientific background at a university level (physics, chemistry, life sciences) and basic engineering skills (such as unit conversions, mass and energy balances).

Final competences

1 Explain how resource consumption and emissions from technological operations affect environmental sustainability.
2 Have knowledge of the nowadays (global) relevant environmental issues.
3 Explain the concepts of clean technology, industrial ecology, circular economy, life cycle thinking and process integration.
4 Apply life cycle thinking when analyzing the sustainability of technological operations.
5 Explain the challenges of prospective sustainability assessment of technological operations.
6 Distinguish environmental, economic and social effects of technological operations.
7 Explain approaches that improve the sustainability of technological operations at the process level, the product design level, as well as the company/management level.
8 Apply mass and energy integration for process optimization.
9 Grasp Material Flow Analysis and metrics to assess circularity.
10 Conduct a basic life cycle assessment study using specialized software and critically discuss the study's limitations and results.
11 Explain methods to assess environmental, economic and social effects of technological operations.
12 Critically interpret the results from methods used to assess the sustainability of technological operations.
13 Grasp process assessment metrics and the concept of exergy and exergy analysis.
14 Quantify the exergy of a flow to the extent defined by presented data and equations.
15 Assess the sustainability performance of a process by quantifying relevant process assessment metrics.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Group work, Seminar, Lecture, Peer teaching

Extra information on the teaching methods

Lectures: theory and guestspeakers from industry. Some lectures can be supplemented with online video material.
Seminar - coached exercises: 2 exercise sessions to solve exercises on process integration and process assessment metrics/exergy.
Seminar - practical PC room classes: 2 coached PC sessions to prepare for the LCA assignment (groupwork).
Groupwork: feedback moment with lecturers for the LCA assignment.
Peer teaching: presentation assignment to other students in week 13.

Study material

Type: Slides

Name: Slides
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes
Online Available : Yes

References

Background material will be made available through the student platform (Ufora).

Course content-related study coaching

Contact hours with the lecturers for individual guidance.

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment with open-ended questions

Examination methods in case of periodic assessment during the second examination period

Written assessment with open-ended questions

Examination methods in case of permanent assessment

Participation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

Periodic evaluation:

- written exam
- study material: theory lectures + guest lectures + exercise sessions

Non-periodic evaluation:

- Presence/participation at 2 coached PC sessions for LCA
- Report and presentation of assignment (groupwork): The assignment is to perform an LCA (compare 2 product alternatives or evaluate the ecodesign of a product) with the aid of software. Students can start the assignment after the first coached PC session to prepare for the assignment (around week 4). Deadline for submission of the assignment (around week 11) and the date of the presentation (week 13) will be provided through the student platform (Ufora).
- Presence/participation at at mandatory feedback moment and assignment presentations of other students

Calculation of the examination mark

Periodic evaluation (written exam): 65% or 13/20
Non-periodic evaluation (assignment, and participation at 2 coached PC sessions, participation at mandatory intermediate feedback moment, and participation at the task presentations): 35% or 7/20
Students who eschew one or more parts of the evaluation may be failed by the examiner. Final scores of 10/20 and above may be reduced to the highest tolerable mark (7/20).
Peer assessment will be performed for the groupwork, hence the final mark per student belonging to the same group may differ. The intermediate and final deadlines for the assignment must be respected, as well as participation at 2 coached PC sessions, the mandatory intermediate feedback moment and the assignment presentations. If not, the final mark may be reduced. If the student obtains a total mark lower than 10/20, the mark obtained for the non-periodic evaluation during the first examination period can be transferred to the second examination period only if the student did not fail, i.e. he/she did not have a mark lower than 3.5/7.