

Environmental Sustainability in Processes and Products

Code: 43328
ECTS Credits: 6

Degree	Type	Year	Semester
4314579 Biological and Environmental Engineering	OB	1	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

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Use of Languages

Principal working language: english (eng)

Other comments on languages

Lectures and course materials will be provided in English. Evaluation and deliverables can be submitted in English, Spanish or Catalan.

Prerequisites

Students must have a solid foundation of the following subjects:

- Energy and material balances
- Important processes of organic and inorganic chemistry
- Knowledge of the physicochemical and toxicological properties of chemical substances.
- Knowledge of thermodynamics.

Objectives and Contextualisation

The main objective of the module is that students combine knowledge and tools to evaluate processes and products to optimize resources (materials and energy) and also to minimize their environmental impacts. The methods, tools and strategies to quantify the environmental impacts in the life cycle are studied. The application of thermodynamic principles is included as a tool to quantify the use of resources in chemical processes, as well as the efficiency in the transformation of raw materials to products. The concepts are explained with examples and case studies to illustrate the applicability of these evaluation tools.

Competences

- Apply methods, tools and strategies to develop biotechnological processes and products with energy-saving and sustainability criteria.
- Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of biological and environmental engineering.

- Communicate and justify conclusions clearly and unambiguously to both specialist and non-specialist audiences.
- Continue the learning process, to a large extent autonomously.
- Integrate knowledge and use it to make judgements in complex situations, with incomplete information, while keeping in mind social and ethical responsibilities.
- Seek out information in the scientific literature using the appropriate channels and integrate this information, showing a capacity for synthesis, analysis of alternatives and critical debate.
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Use IT tools to acquire further knowledge in the field of biological and environmental engineering.

Learning Outcomes

1. Analyse, summarise, organise and plan projects related to the environmental sustainability of products, processes and services
2. Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of biological and environmental engineering.
3. Communicate and justify conclusions clearly and unambiguously to both specialist and non-specialist audiences.
4. Continue the learning process, to a large extent autonomously.
5. Integrate knowledge and use it to make judgements in complex situations, with incomplete information, while keeping in mind social and ethical responsibilities.
6. Interpret and develop life-cycle analyses for products and processes.
7. Know bibliographic sources, calculation diagrams and databases needed to apply risk-quantification methodologies.
8. Know current methodologies for quantifying industrial and environmental risk as a consequence of accidents.
9. Know the main elements of industrial ecology: systems theory, thermodynamics, material flow analysis and resource and energy consumption.
10. Seek out information in the scientific literature using the appropriate channels and integrate this information, showing a capacity for synthesis, analysis of alternatives and critical debate.
11. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
12. Use IT tools to acquire further knowledge in the field of biological and environmental engineering.

Content

Section I. Foundations of Industrial Ecology applied to production processes

1. Principles of Cleaner Production
2. Material, energy and substance flow analysis. The STAN software.

Section II. Life Cycle Assessment

3. Life Cycle Inventory
4. Life Cycle Impact Assessment
5. Interpretation of results
6. Using the Open LCA software

Bloc III. Anàlisi Integrada de la sostenibilitat

7. Environmental Risk Assessment. The EPISUITE Software.

8. System Perspective in Environmental Assessment

Methodology

This is a hands-on training course. It uses the analysis of a production system as case study for group and individual work. We learn different methods for sustainability assessment and the software needed to develop it.

We combine:

- Lectures
- Class exercises
- Computer work
- Student presentations and debates
- A group project that includes the writing of a final report

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theory lecture	26	1.04	9, 7, 8
Type: Supervised			
Supervised work in the classroom	12	0.48	3, 11, 4, 12
Type: Autonomous			
Individual work	15	0.6	9, 7, 8, 5, 3, 11, 4, 12
Team work	89	3.56	1, 2, 10, 7, 6, 5, 11, 4, 12

Assessment

This course follows a continuous evaluation and the grades are distributed as follows:

Group project presentation 25%		Group project report 35%	Deliverables	Debates
Prof Grading	Peer grading			
12%	13%	25% Prof 10% Peers	30%	10%

Group work. The case study will be selected from a list of cases related to the circular economy and polymer production. Some of these cases will be developed jointly with course 43327 Disseny Integrat de Processos integrating the contents of both courses and distributing the workload.

Submission deadlines will be presented during the first day of the course.

Retakes. If the course is failed there will be the possibility of presenting an individual work with an in depth critical analysis of a part of the course contents. The maximum grade granted in this case will be a 5.00.

Grade Reviews. For each evaluation activity, a place, date and time of review will be indicated in which the student can review the activity with the teaching staff. In this context, claims may be made regarding the grade of the activity, which will be evaluated by the faculty responsible for the subject. If the student does not appear in this review, this activity will not be reviewed later.

Honor plates (MH). Granting an honors qualification is the decision of the teaching staff responsible for the subject. The regulations of the UAB indicate that MH may only be granted to students who have obtained a final grade of 9.00 or higher. Up to 5% of MH of the total number of students enrolled can be granted a MH.

A student will be considered non-evaluable (NA) if he has not submitted the project (oral or written) and has not done any of the theoretical and practical tests.

Without prejudice to other disciplinary measures deemed appropriate, the irregularities committed by the student that may lead to a variation in the qualification of an evaluation act will be graded a zero. Therefore, copying, plagiarism, deception, copying, etc. in any of the evaluation activities it will imply suspending it with a zero.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Debates	10%	5	0.2	2, 10, 9, 7, 5, 3, 11
Deliverables	30%	1	0.04	9, 7, 11, 4
Group Project Presentation	25%	1	0.04	1, 2, 10, 6, 3, 12
Group Project Report	35%	1	0.04	1, 2, 10, 9, 7, 8, 6, 5, 3, 11, 4, 12

Bibliography

Textbooks

1. Klöpffer, W., & Grahl, B. (Birgit). (2018). Life cycle assessment (LCA): a guide to best practice.
2. Matthews, H.S., Hendrickson, C.T., Matthews, D.H., 2014. Life Cycle Assessment: Quantitative Approaches for Decisions that Matter.
3. SRI (Stanford Research Institute). Chemical economics handbook. Menlo Park CA: SRI International, 1989. <https://ihsmarkit.com/products/chemical-economics-handbooks.html>
4. Riegel's Handbook of Industrial Chemistry, 2003. , Riegel's Handbook of Industrial Chemistry. Springer US. <https://doi.org/10.1007/0-387-23816-6>
5. John Wiley & Sons, Inc (Ed.), 2000. Kirk-Othmer Encyclopedia of Chemical Technology, Kirk-Othmer Encyclopedia of Chemical Technology. Wiley. <https://doi.org/10.1002/0471238961>
6. Dincer, I., Rosen, M.A., 2007. Exergy: : energy, environment, and sustainable development. Elsevier Ltd. <https://doi.org/10.1016/B978-0-08-044529-8.X5001-0>
7. Brunner, P.H., Rechberger, H., 2016. Handbook of material flow analysis : for environmental, resource, and waste engineers. <https://doi.org/10.1201/9781315313450-4>

8. Miller, R.E., Blair, P.D., 2009. Input-Output Analysis: Foundations and Extensions, 2nd ed. Cambridge University Press.

Articles

1. Guinée, J. B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., Ekvall, T., & Rydberg, T. (2011). Life Cycle Assessment: Past, Present, and Future. *Environmental Science & Technology*, 45(1), 90-96. <https://doi.org/10.1021/es101316v>
2. Burgess, A. A., & Brennan, D. J. (2001). Application of life cycle assessment to chemical processes. *Chemical Engineering Science*, 56(8), 2589-2604. [https://doi.org/10.1016/S0009-2509\(00\)00511-X](https://doi.org/10.1016/S0009-2509(00)00511-X)
3. Suh, S., & Huppes, G. (2005). Methods for life cycle inventory of a product. *Journal of Cleaner Production*, 13(7), 687-697. <https://doi.org/10.1016/j.jclepro.2003.04.001>
4. Finkbeiner, M., Ackermann, R., Bach, V., Berger, M., Brankatschk, G., Chang, Y.-J., Grinberg, M., Lehmann, A., Martínez-Blanco, J., Minkov, N., Neugebauer, S., Scheumann, R., Schneider, L., Wolf, K., 2014. Challenges in Life Cycle Assessment: An Overview of Current Gaps and Research Needs. Springer, Dordrecht, pp. 207-258. https://doi.org/10.1007/978-94-017-8697-3_7 ;
5. Owens, J.W., 1997. Life-Cycle Assessment: Constraints on Moving from Inventory to Impact Assessment. *J. Ind. Ecol.* 1, 37-49. <https://doi.org/10.1162/jiec.1997.1.1.37>

Databases

Ecoinvent <https://www.ecoinvent.org/>

GaBi <http://www.gabi-software.com/spain/index/>

Software

1. OpenLCA <http://www.openlca.org/>
2. STAN <http://www.stan2web.net/>
3. EPISUITE <https://www.epa.gov/tsca-screening-tools/epi-suitetm-estimation-program-interface>