Universitat Autònoma de Barcelona

2022/2023

Environmental Sustainability in Processes and Products

Code: 43328
ECTS Credits: 6

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

Contact

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Use of Languages

Principal working language: english (eng)

Other comments on languages

A good level of English (B2 or higher) is needed to follow the course. 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.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- 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. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
13. 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 LCA software

Section III. Exergy

7. Exergy content

8 Exergy efficiency indicators

Section IV. Anàlisi Integrada de la sostenibilitat

9. Environmental Risk Assessment. The EPISUITE Software.

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

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theory lecture	15	0.6	9, 7, 8
Type: Supervised			
Supervised work in the classroom	23	0.92	3, 4
Type: Autonomous			
Individual work	34	1.36	9, 7, 8, 5, 3, 4
Team work	77	3.08	1, 2, 10, 7, 6, 5, 4

Assessment

This course follows a continuous evaluation. The table shows an orientation of how grades are calculated. Please check syllabus for updated percentages.

Group project 45%	Individual Deliverables	Colleague evaluation

45% Prof	45%	10%

Group work. The case study will be selected from a list of cases related to the circular economy and polimer 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 th first day of the course.

Retakes. If the course is failed there will be the possibilty 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 bereviewed 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 begrantedto 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
Colleague evaluation	10%	0	0	12, 1, 2, 10, 9, 7, 8, 6, 5, 11, 3, 4
Group Project	45%	1	0.04	12, 1, 2, 10, 9, 7, 8, 6, 5, 11, 3, 4, 13
Individual Deliverables	45%	0	0	12, 1, 2, 10, 9, 7, 8, 6, 5, 11, 4, 13

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.
9. Allen & Shonnard. 2018. Green Engineering: Environmentally Conscious Design of Chemical Processes. 2nd Edition.

Articles

A list of articles will be provided with the syllabus

Software

Databases

Ecoinvent https://www.ecoinvent.org/

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

Software

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