

**Industrial Ecology**

Code: 42405  
ECTS Credits: 9

Degree	Type	Year	Semester
4313784 Interdisciplinary Studies in Environmental, Economic and Social Sustainability	OT	0	1

**Contact**

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**Use of Languages**

Principal working language: english (eng)

**Teachers**

Martí Rufí Salís

Susana Toboso Chavero

**Prerequisites**

*NO REQUIREMENTS*

**Objectives and Contextualisation**

This course is an introduction to the field of Industrial Ecology (IE) as a multidisciplinary effort to evaluate anthropogenic systems, minimizing their negative effect on our planet. The students are taught the methods, tools, and strategies within IE, aimed to recreate our industrial system in such a way that it can be sustainable and in harmony with the rest of the natural ecosystem. To achieve this general objective, the module is divided in three blocks:

Block 1 (3 ECTS). Tools and methods within IE. The objectives of this block are:

- Understand the concepts of IE, its framework as a multidisciplinary area of research based on system theory; resources: environmental goods and services, externalities.
- Understand Material Flow Analysis (MFA), and be able to apply this tool to different systems, such as a product, process, or region.
- Understand the concepts of urban metabolism, carbon footprint, including differences in scope, results, and policy implications.
- Understand both process-based approach, MFA-LCA (or Material Flow Analysis coupled with Life-Cycle Assessment) and EIO-LCA (or Economic Input-Output coupled with Life-Cycle Assessment); apply the fundamentals of these approaches to be used for various analyses (e.g., GHG, pollution, water, land, toxics, materials use, etc.)

Block 2 (3 ECTS). Life Cycle Assessment (LCA). The main objectives are:

- Understand the concept of LCA, its applications and the global framework for its use.
- Understand the main steps of LCA (i.e., goal and scope definition, inventory analysis, impact assessment and interpretation) and be able to apply them to different real-life cases, such as products or services.

- Learn how to evaluate and interpret the results, assumptions and uncertainties in case studies from a critical point of view.
- Learn how to use the SimaPro software and its basic functionalities and be able to calculate the environmental impacts of a system by means of it.
- Apply the SimaPro software to compare a sustainability product and a conventional good from a life cycle perspective and represent its results in a poster.

Block 3 (3 ECTs). Eco-design and sustainable urban systems. The objectives of this block are:

- Understand the concept of eco-design and the role of LCA, as well as the basic theoretical aspects, regulations and legal framework.
- Learn about the application of IE tools and methods to urban systems for increasing its environmental sustainability.
- Learn the basic principles of sustainable urban planning and understand its process.
- Learn how to use the Gabi software and its basic functionalities and be able to calculate the environmental impacts of a system by means of it.

Apply the GaBi software to assess urban infrastructures (pavements, distribution networks, ...) from a life cycle perspective.

## Competences

- Analyse, summarise, organise and plan projects related to the environmental improvement of product, processes and services.
- Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of Environmental Studies.
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
- Work in an international, multidisciplinary context.

## Learning Outcomes

1. Analyse research results to obtain new products or processes, assessing their industrial and commercial viability with a view to transferring them to society.
2. Apply knowledge of the different tools of industrial ecology to systems independently of scale.
3. Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of Environmental Studies.
4. Apply the concepts learnt in class, make assessments and take decisions based on results.
5. Interpret and develop life-cycle analyses for products and processes.
6. Know the main elements of industrial ecology: systems theory, thermodynamics, material flow analysis and resource consumption.
7. Know the tools of eco-innovation that are applicable to urban environments.
8. Know urban systems and their indicators in order to evaluate them.
9. Work in an international, multidisciplinary context.

## Content

Block 1 (3 ECTs). Tools and methods within IE. The contents of this block are:

- Industrial Ecology and Technological change.
- System Theory, economic valuation, externalities.
- Introduction to material flow analysis.
- Introduction to urban metabolism, carbon footprint and case studies.
- Introduction to process-based approach, MFA-LCA (or Material Flow Analysis coupled with Life-Cycle Assessment), using actual energy use data to model systems; and EIO-LCA (or Economic Input-Output coupled with Life-Cycle Assessment), which adopts IO tables to study the inter-dependencies of

economies. The fundamentals of these approaches will be used for various analyses (e.g., GHG, pollution, water, land, toxics, materials use, etc.)

This block 1 is taught by Dr. Carles Martínez Gasol & Dr. Cristina Sendra

Block 2 (3 ECTs). Life Cycle Analysis. The contents of this block are:

Development of LCA

- Introduction to LCA
- Environmental tools
- Interpretation and uncertainty
- Case studies

Theoretical part of block 2 is taught by Dr. Carles Martínez Gasol and Dra. Julia Martínez

Introduction to SimaPro Software

- SimaPro: Introduction to the software
- Inventory creation. Introduction of the information programs
- Impact assessment in SimaPro. Analysis of sensibility.
- Presentation LCA in SimaPro. Development of case of studies, led by students

Practical part of block 2 is taught by MSc. Susana Toboso & MSc. Martí Rufi

Block 3 (3 ECTs). Sustainable urban systems. The contents of this block are:

- Introduction to ecodesign
- Ecodesign strategies
- Eco-innovation and eco-labels
- Case study of LCA of an urban element, led by students
- Introduction to GaBi + practical exercises + student case study

Theoretical part of block 3 is taught by Dr. Jesús Boschmonart and Dr. Carles Martínez Gasol & the practical part is taught by MSc. Susana Toboso & MSc. Martí Rufi.

## Methodology

Block 1 (3 ECTs). Tools and methods within IE. The 2.5 ECTs of this block are divided the following way:

- 15 hours of class, this includes theory and exam.
- 35 hours of readings and studies outside the classroom (individual and group)
- 11.5 hours dedicated to individual class project.
- Class time: The theory classes will provide the students with the knowledge necessary to understand the readings and be able to do exercises outside the classroom. Time will be allotted for questions, interaction, and debate. At the beginning of each class, there will be a 10 to 15 minute quiz based on the previous class and the readings due that day.
- Work outside the classroom: The reading assignments will be used both as a preparation for understanding the theory class (very basic, general audience readings), and to go further in-depth with more specific and technical readings. Most of these will be done in group to motivate team work and improve communication skills within a multidisciplinary, multicultural environment.
- Individual class project: This will give the student the opportunity to apply the knowledge acquired during the course to a specific case study assigned in class.
- This block is taught by Dr. Carles Martínez & Dra. Cristina Sendra

Block 2 (3 ECTs). Life Cycle Analysis.

- 24 hours of class. This includes theory and computer lab.
  - 12 hours of LCA theory and applied theory to case studies
  - 9 hours of computer Lab (SimaPro). Two simultaneous practical class in two computer labs will be offered for 2 students groups.
  - 3 hours of presentation of individual projects
  - 25 hours of readings (papers and case studies) and studies outside the classroom (individual and group)
  - 23.5 hours dedicated to produce the LCA of a specific case study assigned in class.
  - Class time: The theory classes will provide the students with the knowledge necessary to understand the application of LCA tools in the analysis and design of sustainable products.
  - Work outside the classroom: The product/service ecodesigned will be carried out of the classroom in order to ensure that students have understood theory classes, and to put concepts in practice.
  - Individual and group projects: Research of the product/service experience; determination of objectives and scope of the environmental assessment; development inventories; modelization of the solar cooking SimaPro; Interpretation of environmental outcomes and selection of the environmental indicators and validation of the ecodesign.
- The theoretical part of this block 2 is taught by Dra. Julia Martínez & Dr. Carles Martínez. The practical part is taught by MSc. Anna Petit & David Sanjuan.

Block 3 (3 ECTS). Eco-design and sustainable urban systems.

- The 3 ECTS of this block are divided in the following way:
  - 18 hours of class. This includes theory and computer lab:
  - 6h of eco-design
  - 9 hours of computer lab (GaBi). Two simultaneous practical class in two computer labs will be offered for 2 students groups.
  - 3h exam
  - 13,5 hours of readings and studies outside the classroom (individual and group)
  - 35 hours dedicated to groups class projects.
- Class time: The theory classes will provide the students with the knowledge necessary to understand the application of IE tools and methods in the analysis and design of sustainable urban systems.
  - Work outside the classroom: Some exercises will be carried out of the classroom in order to ensure that students have understood theory classes, and to put concepts in practice.
  - Individual project: Design and construction of a product/service. The inventory data used to produce this device will be later used to carry out an LCA with SimaPro in Block 2. The design, the materials and the heating temperature will be tested.
  - Group project: during the block project development many tasks will be done by students:
  - Determination of the case study
  - Research of the urban element
  - Determination of objectives and scope of the environmental assessment
  - Development and research of inventories, and bibliography research.
  - Modelization of the urban element in GaBi
  - Environmental assessment of the urban element
  - Interpretation of environmental outcomes and selection of the environmental indicators to focus on to the re-design of the urban element according to environmental briefing
  - Validation of the re-design of the urban element
- The theoretical part of this block 3 is taught by Dr. Jesús Boschmoanrt & Dr. Carles Martínez. The practical part is taught by MSc. Anna Petit & David Sanjuan.

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## Activities

Title	Hours	ECTS	Learning Outcomes
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Type: Directed

Industrial Ecology- Theory Classes	12	0.48
LCA-IO Table - Theory Classes	9	0.36
MFA - Theory Classes	12	0.48
Type: Supervised		
Gabi Computer Lab	9	0.36
SimaPro Computer Lab	12	0.48
Type: Autonomous		
Gabi project	14.5	0.58
Input-Output tables and LCA	11.5	0.46
LCA projects - Readings, study, work in groups and preparation for presentations	24	0.96
MFA project- Readings, study, work in groups and preparation for presentations	38	1.52
SimaPro - Readings, study, work in groups and preparation for presentations	35	1.4
SimaPro project	33	1.32

## Assessment

The grade of the module is made up of the following percentages:

-34 % block 1

-33 % block 2

-33 % block 3,

To pass the module, the student must have at least a grade of 4.0 in each block, the combined grade must be greater than 5. If the student fails the module, he or she will have to register again for the entire module.

Block 1: Evaluation will be 50% based on participation and 50% based on a final exam.

The participation grade is composed of:

1. Quizzes (Individual). Each class will begin with a 10-15 minute quiz based on the previous class and the assigned readings. Apart from ensuring a continuous effort from part of the students, this will also motivate them to arrive punctually to class, already in thinking mode. Also included in "participation" are the. Both the quizzes and small presentations have equal weight.
2. Presentations (group). There will be either 2 or 3 presentation assignments during the course.
3. Class activities (group). There will be either 1 or 2 activities during the course, after which the students must be able to communicate results.
4. Final project to be announced in class- individual or group.

Block 2:

Evaluation will be 50% theory and 50% lab activities.

Block 3:

- A short assignment will be conducted by the students.
3. LCI of the urban element (group) - 10%. The inventory of materials used by the students to conduct the LCA of their urban element must be ready on the assigned date.
  4. Attendance and participation - 10%.

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Individual daily quiz	15%	1.5	0.06	2, 3, 6, 4, 9
Gabi- Project presentation	20%	0	0	3, 8, 7, 5, 4, 9
MFA Final Class Project	30%	11.5	0.46	1, 2, 3, 4, 9
Sima Pro project presentation	20%	2	0.08	2, 6, 5, 4
input output exercise	15%	0	0	2, 3

## Bibliography

Block 1. Available with syllabus, given at the beginning of class.

Block 2. Available with syllabus, given at the beginning of class.

Block 3. Available with syllabus, given at the beginning of class.

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Ceron-Palma I, Oliver-Solà J, Sanyé-Mengual E, Montero JI, Rieradevall J (2012) Barriers and opportunities regarding the implementation of Rooftop Greenhouses (RTEG) in Mediterranean cities of Europe. *Journal of Urban Technology*, in press

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Fundació La Caixa (2007) *Ecodiseño. Área de Medio Ambiente y Ciencia - Fundació La Caixa*, Barcelona.

González-García S, García Lozano R, Estévez J, Pascual R, Moreira MT, Gabarrell X, Rieradevall J, Feijoo G (2012a) Environmental Assessment and Improvement Alternatives of a Ventilated Wooden Wall from LCA and DfE Perspective. *Int J LCA* 17 (4): 432-443.

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