



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Low Environmental Impact Materials and Processes

2122-1-F5302Q014

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#### Aims

##### General aims

The course aims to provide the knowledge and methodological basis to define a process with low environmental impact. The course will then focus on some chemical processes that can currently be defined as having a low environmental impact.

##### *Knowledge and understanding*

At the end of the course the student will have a fundamental understanding of:

- The main parameters to be evaluated to define a low environmental impact process.
- The correct definitions of green chemistry and circular economy.
- The scientific problems to move from the oil-based economy to the green economy.

##### *Applying knowledge and understanding*

At the end of the course the student will be able to:

- apply the concepts of green chemistry learned in the course that form the basis of sustainable development according to the UN 2030 agenda.
- judge whether a process qualifies as a green and/or sustainable process.

### ***Making judgements***

At the end of the course the student will be able to

- apply the acquired knowledge in various contexts.
- transfer concepts and approaches to new fields.
- elaborate the topics of the course.

### ***Communication skills***

At the end of the course the student should be able to

- analyse a problem related to the course topics in a clear and concise way.
- explain orally with a suitable language the objectives, the procedures and the results of the elaborations carried out.

### ***Learning skills***

At the end of the course the student should be able to apply the acquired knowledge to different contexts than those discussed during the course.

## **Contents**

- Environmentally compatible processes for the production of materials.
- Environmentally compatible processes for the production of fine chemicals.
  
- Environmentally compatible processes for energy production.
- The concept of green chemistry.
- The concept of biorefinery.
- Biotechnology and energy aspects in the biorefinery context.
- Potentially sustainable concepts for performing chemical reactions.
- Sustainable nanomaterials.

## **Detailed program**

- Evolution of industrial syntheses with low environmental impact on the basis of selected examples.
- The twelve rules of green chemistry.
- Evolution of the concept of green chemistry.
- Carbon economy concept.
- Description of the main renewable sources with particular reference to the structure of lignocellulosic

materials.

- The concept of bio-refinery with examples and applications in Italy and Europe.
- Evolution of the paper industry from an environmental point of view, also looking at the possibilities of using by-products.
- Description of the problems associated with the recycling and reuse of materials.
- Synthesis of new biodegradable and non-biodegradable materials starting from renewable sources with low environmental impact processes.
- Bulk modifications and surface modifications of materials.
- Methods for assessing the environmental impact in the form of carbon-footprint.
- Synthesis of chemicals from renewable sources with low environmental impact processes.
- The integration of low environmental impact processes in the circular economy.
- Older and newer concepts for performing chemical reactions, e.g., flow chemistry or mechanochemistry.
- Synthesis and advantages of sustainable nanomaterials, regulatory aspects.

## Prerequisites

- Basic knowledge of organic and inorganic chemistry, and biology
- Basic concepts of thermodynamics.

## Teaching form

- Theoretical lessons in the classroom (6 credits).
- In the event of a COVID-19 emergency, the course will be held through remote lessons that will be additionally recorded and uploaded to the elearning web-site of the course.

## Textbook and teaching resource

- P.T. Anastas  
*Green Chemistry - Theory and Practice* PT Anastas

Oxford University Press

- Bruno Rindone  
*Introduzione alla Chimica Ambientale B*  
Città Studi Edizioni
- M. Aresta, A. Dibenedetto, F. Dumeignil  
Biorefineries - An introduction  
De Gruyter
- Slides shown during the lectures and notes as well as additional material on selected topics, i.e., scientific articles, that will be available on the elearning web-site of the course.

## Semester

II semester (march - june)

## Assessment method

The final exam consists of an oral exam at the end of the course, with a score between 18-30/30, which consists of the discussion of various topics discussed during the lessons, linking the concepts to an industrial process or to a new biorefinery or green chemistry process presented in a scientific article, to arrive at a critical evaluation of the presented process from the point of view of overall sustainability.

The discussion of the exam is based on a short 10-minute powerpoint presentation that must be prepared by the student for the exam; the article and / or documentation of the process to be evaluated will be sent to the student one week before the exam.

In the event of a pandemic emergency, the exam will always be as described above, but held on the Webex platform.

## Office hours

Always, after scheduling an appointment *via* phone or e-mail.

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