UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Principles of Sustainable Chemistry

2223-1-F7501Q104-F7501Q113M

Aims

General aims

The course is aimed at providing the knowledge and methodological bases to know and understand the principles that define sustainable and / or green chemistry. The course will focus on some processes and practices that can currently be linked to the concept of sustainability and respect for the environment, as examples for specific broader discussions on the issues touched upon during the course.

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

- The concepts of green chemistry and sustainable chemistry, their commonalities and their differences.
- The concept of biorefinery for the production of sustainable raw materials.
- Sustainable processes for the production of standard materials and 'high-performance' materials.
- Sustainable processes in the field of chemistry for the production of fine chemicals.
- Sustainability in the field of nanomaterials.
- Aspects on sustainable energy.
- Responsible and sustainable use of non-renewable resources such as metals.

Detailed program

- Evolution of sustainability in industrial syntheses on the basis of selected examples.
- Evolution of the concepts of green chemistry and sustainable chemistry.
- Common points and differences between green chemistry and sustainable chemistry.
- Main biogeochemical cycles.
- 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, also in view of the circular economy.
- Description of the problems associated with the recycling and reuse of various materials, including precious metals.
- Synthesis of new biodegradable and non-biodegradable materials starting from renewable sources with sustainable processes.
- Synthesis of chemicals from renewable sources with sustainable processes.
- Sustainable and / or green concepts for performing chemical reactions, for example flow chemistry.
- Bulk modifications and surface modifications of materials in a sustainable way.
- The integration of sustainable processes within the circular economy and their construction.
- Synthesis and advantages of sustainable nanomaterials, and the regulatory aspects.
- Sustainable alternatives in adjacent fields: point-of-care-devices, organ-on-a-chip, model organisms.

Prerequisites

- Basic knowledge of organic and inorganic chemistry and biology.
- Basic notions of thermodynamics.

Teaching form

- Theoretical lessons in the classroom (48 h).
- Case studies, to be prepared during the lessons by the students in groups according to various schemes, with final discussions together.
- In the event of a COVID-19 emergency, the course will take place through remote lessons which will also be recorded and uploaded to the course's e-learning site.
- I work on current case studies to understand on the basis of the examples the concept of sustainability in chemistry and the relationship with green chemsitry.

Textbook and teaching resource

- M. Aresta, A. Dibenedetto, F. Dumeignil
  Biorefineries - An introduction
  De Gruyter

- slides

- notes shown during lectures and additional material on selected topics, i.e., scientific articles, made available on the e-learning website of the course.

Semester

First half of 1st semester (october - november)

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 and co-estolizing the concepts / processes reported, to arrive at a critical evaluation of work from the point of view of sustainability in chemistry as a whole. The discussion of the exam is based on a short 10-minute powerpoint presentation that must be prepared by the student as part of the preparation 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.
The student will be assessed at the end on the basis of the following criteria: (1) knowledge and understanding; (2) ability to connect different concepts; (3) autonomy of analysis and judgment; (4) ability to use scientific language correctly.

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

Office hours

Always, preferably by appointment by phone or e-mail.

Sustainable Development Goals

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE | SUSTAINABLE CITIES AND COMMUNITIES | RESPONSIBLE CONSUMPTION AND PRODUCTION