



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Converting Chemical Innovation To Sustainable Products and Processes

2627-2-F7603Q004-F7603Q00402

Aims

This module will highlight and showcase the journey from sustainability-driven innovations in the materials field to modern commercialised processing and products. Covering also the strategies that can be applied when developing an innovation to a product available on a market, the process of developing an innovation is shown. Using illustrative cases, it is further demonstrated that the original innovation is sometimes not directly clear when looking at the ready-made product or process that is contributing to a fostered (environmental) sustainability.

The topics of this module are closely related to some aspects of the second module, and teaching will, as necessary and beneficial for general understanding of interconnectivities of taught aspects, see incorporation of parts of the other module.

Knowledge and understanding

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

- the main steps needed to develop an innovation to a application level.
- the importance of fundamental discoveries for the generation of sustainable solutions.
- the fundamental role of natural sciences in the development of modern and sustainable materials and products.

Applying knowledge and understanding

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

- understand the challenges connected to the development of an innovation.
- develop strategies to valorize innovations in given contexts.

Making judgements

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

- apply the acquired knowledge in various contexts.
- transfer the concepts and approaches introduced in a certain context to connected fields.
- understand the complexity connected to identifying ground-breaking innovations and the potential from sequential incremental innovations.

Communication skills

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

- analyse an innovation and the process of its valorization in a clear and concise way.
- explain orally with a suitable language the objectives, the procedures and the results of eventual elaborations carried out during the course.

Learning skills

At the end of the course the student should be able to trace back the underlying innovation that enabled a sustainable product, such as to eventually be able to recognize valuable innovative efforts. The student should be able to relate the aspects seen in this course to the arguments covered in the innovation related modules of the first year and the other module of this course.

Contents

- flow chemistry;
- natural catalysts;
- point-of-care analytics;
- organ-on-a-chip;
- soft robotics.

Detailed program

- flow chemistry: modern tools for chemical synthesis in the fields of pharmaceutical products and crop sciences;
- natural catalysts: opportunities and challenges using enzymes, synthetic enzymes, and inorganic catalysts for synthesis of modern polymers;
- modern resources derived from natural compounds: valorization methods for biomass, producing fuel and platform chemicals for modern, sustainable materials;
- modern analytical tools for point-of-care analytics, as such compatible with sustainability objectives and low-cost manufacturing;
- organ-on-a-chip and system biology: modern tools for streamlining biological research and the development of modern pharmaceutical products;
- soft robotics: from early models to self-sustained autonomous systems.

Prerequisites

- basic ideas of value chain generation
- basic notions on innovation

Teaching form

- 4 CFUs of theoretical lessons in the classroom (32 hours):
 - > 16 two-hour lectures, in person; Delivered Didactics;
 - > 16 two-hour lectures, in person, reading and discussing scientific articles in aula, and interventions from

experts; Mixed Didactics, / Seminar.

- Case studies, to be prepared during the lessons by the students in groups according to various schemes, with final discussions together.

Textbook and teaching resource

- 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

I semester (October - January)

Assessment method

The final exam consists of a single oral exam at the end of the course, with a score between 18-30 / 30 cum laude, which comprises the discussion of various topics covered in the module and the course as a whole, eventually in the form of a presentation, with an emphasis also on the connections between concepts and processes, such as to arrive at a critical evaluation of work from the point of view of sustainability in chemistry as a whole.

The final score will range from 18/30 to 30/30 with honors, based on the overall assessment, taking into account the following criteria:

1. conceptual knowledge and understanding
2. ability to apply knowledge and understanding
3. communication and argumentation skills
4. learning, self-assessment, and self-regulation skills

Grade < 18

Knowledge and Understanding: The student only partially identifies the characteristics of the concepts. The connections between the concepts are fragmented and poorly supported by theoretical knowledge.

Ability to apply knowledge and understanding: The student identifies only a few relevant elements in a phenomenon, unable to integrate them into a coherent analysis.

Communication and Argumentation Skills: In the oral exam, the student develops a basic argument, lacking logical structure and characterized by numerous expository inaccuracies.

Learning, self-assessment, and self-regulation skills: The student is able to reconstruct only some aspects of their learning and professional development journey.

Grade 18-22

Knowledge and Understanding: The student recognizes and explains most of the conceptual features and is able to provide a relatively coherent explanation, albeit with some inaccuracies. Theoretical references are present but not always rigorously.

Ability to apply knowledge and understanding: The student is able to recognize a significant number of elements and provide a partial explanation, while highlighting some gaps in the analysis.

Communication and argumentation skills: In the oral exam, the student constructs a basic argument, with a minimal

structure but with some inaccuracies.

Learning, self-assessment, and self-regulation skills: The student demonstrates a basic awareness of their learning path, managing to draw essential connections between learning experiences, albeit with some inaccuracies.

Grade 23-27

Knowledge and Understanding: The student demonstrates a thorough understanding of conceptual characteristics. In the oral exam, explanations are well-articulated and supported by an appropriate use of theoretical references.

Ability to apply knowledge and understanding: The student accurately identifies the essential elements of a phenomenon. The application of knowledge occurs with methodological rigor that is not always solid.

Communication and argumentation skills: In the oral exam, the student develops a coherent and well-organized argument, demonstrating good command of language and a solid logical-argumentative structure. Communication is clear and effective.

Learning, self-assessment, and self-regulation skills: The student analyzes his or her learning journey in a clear and structured manner, highlighting significant relationships between the various developmental stages and demonstrating a good capacity for critical reflection.

Grade 28-30

Knowledge and Understanding: The student demonstrates a thorough mastery of concepts, articulating complex connections and providing comprehensive explanations. Theoretical references are used with relevance and rigor.

Ability to apply knowledge and understanding: The student demonstrates an advanced ability to analyze a phenomenon, comprehensively identifying and interpreting all salient elements. Knowledge is applied with methodological rigor, supported by solid and detailed argumentation.

Communication and argumentation skills: In the oral exam, the student develops a solid and detailed argument, with a rigorous logical structure and a high level of textual coherence. The presentation is fluent and well-structured.

Learning, self-assessment, and self-regulation skills: The student demonstrates an advanced capacity for self-reflection, developing a detailed and in-depth analysis of their learning and professional development journey. The connections between learning experiences and theoretical concepts are clear, coherent, and rigorous.

Office hours

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

Sustainable Development Goals

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