UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Organic and Polymeric Formulations

**2223-1-F5401Q066**

## Aims

**General objectives**

To present the basic concepts of formulation chemistry (with references to the physical chemistry of interfaces and interphases), the classes of organic and polymeric compounds used in the field and the main industrial and scientific and technological research applications.

**Knowledge and understanding**

At the end of the course the student:

1) Can distinguish the type of formulation under examination on the basis of its components (micellar solution, emulsion, dispersion, microemulsion, foam, solid formulation)

2) Can clearly identify active components and compatibilizing additives in a formulation

3) Knows the main descriptive tools of complex interfaces and interfaces constituting the formulations

4) Knows the methods of main characterization of colloidal dispersions

**Applying Knowledge and understanding:**

1) Can propose methods of preparation of a given formulation according to its nature

2) Can propose further lines of development of existing formulations, checking in particular: stability, rheological properties, appearance, availability of the active ingredient

3) Knows the main areas of application of the chemistry of formulations

4) Is able to develop original formulations, mainly based on water as the dispersing medium

**Making judgments.**

The student can contextualise classic problems of the chemistry of formulations such as dispersion in a lyophobic environment, selective delivery and the dosage over time of an active ingredient. Can propose original formulations to handle the aforementioned problems in areas such as: detergency, drug delivery, paints, adhesives, agro-food formulations, cosmetics and special reactive formulations

**Communication skills.**

The student knows the specific terminology of the chemistry of the formulations and is able to use it both in written form and in oral form, in order to summarize in a complete and concise way the characteristics and the possible solutions of formulation problems.

**Learning skills.**

The Student is able to extend what has been learned in classes to case studies not covered during the course. He is in particular able to autonomously manage the wide technical literature dedicated to the Formulations. He knows the research tools of the dedicated literature, including patents.

## Contents

Definition of formulation and general introduction to the role of formulations in industrial and reaserch applications. Recalls of Physical Chemistry of interfaces and interphases (interphase processes, surface tension). Introduction of the concept of surfactant, its characteristics and description of behavior in complex mixtures. General description of the application of formulations in the agri-food, adhesive, cosmetic, pharmaceutical and dye industry fields. Advanced application of the chemistry of organic formulations: micellar synthesis, advanced systems for biological imaging and drug delivery, colloidal organic nanostructures.

## Detailed program

Relevance of the chemistry of formulations, with examples related to commercially available products and new technological applications. Definition of surfactant and structure property relationships. Recalls on the self-assembly processes in solution. Thermodynamic aspects of the formation of colloidal structures. Micellar critical concentration: definition, methods of measurement and dependence on the characteristics of the formulation. Phase diagrams of amphiphilic systems. Emulsions and microemulsions. Foams. Features of a microemulsion. Liposomes: preparation, features and applications. Qualitative and quantitative descriptors of the chemical-physical characteristics of the components an emulsion. Main classes of organic and polymeric surfactants: preparation, properties, scopes of application. The HLB system, principles and applications. Rheological properties of non-Newtonian fluids. Basic principles, components and examples of formulations for: detergency, adhesives, drug delivery, paints, formulations of agri-food interest, formulations for dyeing. Reactive formulations.

Relevant equipment for the production and characterization of formulations.

in addition to the classes, the following experiments will be shown and discussed in the classroom:

1) Determination of the cloud point of a surfactant and its mixtures with co-surfactants of the same and of other classes

2) Formation and stability of an emulsion according to the preparation techniques used.

3) Microencapsulation using the Mini Emulsion Solvent Evaporation

4) Preparation and characteristics of a microemulsion

5) Preparation of a microencapsulated by coacervation

6) Reactions of cross coupling in micellar environment

7) Transport in aqueous environment of lipophilic fluorescent compounds by micelle preparation

8) Estimate of the HLB value of some surfactants of industrial interest

9) Microencapsulation for interfacial polymerization

In all cases it will be video accompanied by a commented ppt videolessation.

## Prerequisites

Sound basic knowledge of organic, inorganic and physical chemistry. Capability to handle the topics of general chemistry.

## Teaching form

Standard lessons supplemented by supporting multimedia tools functional to a better understanding of the practical aspects.

All classroom lessons will still be videotaped and made available immediately after class.

## Textbook and teaching resource

Textbooks

1. Formulation Technology: Emulsions, Suspensions, Solid Forms Author(s):Dr. Hans Mollet, Dr. Arnold Grubenmann 2001 WILEY?VCH Verlag GmbH
2. Jonathan W. Steed, David R. Turner, Karl J. Wallace, Core Concepts in Supramolecular Chemistry and Nanochemistry, John Wiley&So

Slides

Videorecording of classes

## Semester

first

## Assessment method

Oral interview aimed at verifying the capability to recognise the specific function performed by each element introduced in a complex formulation. Knowing how to distinguish the nature of a formulation based on its components. Knowing how to select, at least for general classes, the components of a formulation based on the nature of the active principle and the final application.

Understanding the main fields of application of the chemistry of formulations. Knowing how to correctly classify surfactants both from the point of view of their applications and their structural characteristics.

Knowing how to propose strategies to develop innovative formulations, once the constraints related to the particular target application are known.

## Office hours

upon request

## Sustainable Development Goals

SUSTAINABLE CITIES AND COMMUNITIES | RESPONSIBLE CONSUMPTION AND PRODUCTION