Chemistry of polymers

1. **Course number and name:** 020CHPCS1 Chemistry of polymers

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours

3. **Names of instructors:** Maher ABBOUD

4. **Instructional materials:**
   - Course handouts
   - References
     - Polymer Chemistry – An introduction; Malcom Stevens; Oxford University Press
     - La polymérisation : principes et applications ; Georges ODIAN ; Polytechnica
     - Introduction à la chimie macromoléculaire ; Cours de chimie ; Georges Charpentier ; Lucien Monnerie ; Masson
     - Polymères : Structures et propriétés ; Christian OUDET ; MASSON
     - Chimie et physico-chimie des polymères ; Michel Fontanille ; Yves Gnanou ; DUNOD

5. **Specific course information**
   a. **Catalog description:**
   Chapter I - Introduction - Definition of polymers, nomenclature and classifications, Chapter II - Notions of macromolecules: chain of units, tacticity and macromolecular masses, Chapter III - Polymerization reactions and techniques: step polymerizations - chain polymerizations, Chapter IV - The polymers and the cohesion of macromolecular systems, Chapter V - Morphology in the condensed state, Chapter VI - Phase transitions, Chapter VII - Special structures, Chapter VIII - Thermomechanical properties of polymers, Chapter XI - Additives and adjuvants in polymers - Polymer transformation processes.

   b. **Prerequisites:** 020CORNI3 Organic Chemistry

   c. **Required/Selected Elective/Open Elective:** Required

6. **Specific goals for the course**

   a. **Specific outcomes of instruction:**
   A student who has taken this course will be able to:
   - Identify the difference between polymeric macromolecular materials and other ceramic, metallic, molecular materials.
   - Know how to illustrate the chemical structure in structural formula of a polymer after its identification
   - Represent the physical architectures of macromolecular chains within a linear thermoplastic and cross-linked elastomeric or three-dimensional thermosetting polymer
   - Know how to distinguish a polymer obtained by step polymerization and another obtained by chain polymerization and differentiate between the two types of polymerization

- Describe the concept of average macromolecular masses and the degree of polymolecularity and calculate them
- Express Carothers theory for dealing with stepwise polymerization reactions under stoichiometric and non-stoichiometric conditions. Relate and predict the characteristics of the polymer product.
- Establish the kinetic laws governing the stages of radical polymerizations and understand the dependence of the length of the chains and the rate of polymerization with the initiator and the monomer
- Classify polymerization processes (in bulk, in solution, in suspension and in emulsion) and be able to recognize the differences on an industrial scale. Learn more about suspension and emulsion polymerization processes.
- Establish the laws of kinetics and chain composition in the case of radical copolymerization in order to understand the architectures of the final macromolecules obtained: interpret composition drift.
- Know how to recognize a given polymer, representing it in space and evaluating its volume cohesion density in order to assess its resistance.
- Differentiate between the structures in the condensed state of amorphous polymers and crystalline or semi-crystalline polymers.
- Know how to define the glass transition and relate it to the different macromolecular movements intrinsic to the material.
- Identify the parameters that influence the glass transition in polymers and know how to explain the role of each.
- Interpret the thermal behavior of a semi-crystalline polymer with softening and melting transitions (distinguish between second order transition and first order).
- Identify highly anisotropic materials, their strengths and weaknesses (case of fibers) and thermoplastic and cross-linked elastomeric polymers.
- Establish and interpret the laws of variation of Young's modulus (in mechanical test) as a function of temperature in the case of homopolymers or random copolymers, or even when adding adjuvants such as plasticizers.
- Know how to differentiate between the behavior of an elastic, plastic and viscoelastic material and establishing curves for the variation of stresses as a function of deformation for any type of polymer.
- Know how to recognize the most common industrial processes transforming polymers as well as the main adjuvants added in industrial formulations.

b. PIs addressed by the course:

PI	1.3	2.2	3.1	5.2	7.1	7.2
Covered	x	x	x	x	x	x
Assessed	x	x	x	x	x	x

7. Brief list of topics to be covered

- Introduction – Definition of polymers, nomenclature and classifications
- Polymers and the cohesion of macromolecular systems

- Notions of macromolecules: Sequence of units, tacticity and macromolecular masses
- Polymerization reactions and techniques: step polymerizations and chain polymerizations=
- Morphology in the condensed state
- Phase transitions
- Special structures
- Thermomechanical properties of polymers
- Additives and adjuvants in polymers - Polymer transformation processes