Separation techniques

1. **Course number and name:** 020TESCS3 Separation techniques

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 contact hours

3. **Name of instructor:** Marina Daccache

4. **Instructional Materials:**
   - PowerPoint slides
   - Solved exercices

5. **Specific course information**
   a. **Catalog description:**
   Physical aspects of phenomena (Definition, Application). Balances, solutions and solubility, choice of solvent. Analysis by macroscopic assessments: variance, assessment, operating curve and operating diagram. Countercurrent absorption of a constituent: Cut. Extent of the problem and assumptions. Algebraic resolution. Graphics processing. Distillation of a binary mixture. MacCabe and Thiele method -Ponchon-Savarit Method-Impact of operating conditions. Multi-constituent distillation. Analysis of the Problem-Short Cut Method (Relation of Fensk, Underwood, Gilliland, Kirkbridge). Choice of solvent, characteristics and properties of solvents. Balances between liquid phases. Study of single contactors, with multiple contacts and countercurrents without and with reflux. To know the mechanisms of liquid-solid separation and the fundamental equations allowing to dimension the industrial devices of this separation. Decanting, theoretical study - Falling speed limit. Experimental study. Modeling of continuous settlers with vertical walls. Sizing of continuous decanters with vertical walls. Filtration: Definitions and related techniques. Theory of filtration on support. Application examples. Membrane filtration: Separation membrane techniques. Osmotic pressure. Polarization phenomenon. Clogging mechanisms. Electro dialysis compartments. Centrifugation: Centrifugal effect and centrifugal filtration pressure. Centrifugal spin and flow rates

   b. **Prerequisites:** 020THCCS1 Chemical thermodynamics

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

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
      - Understand the physical principles of separation phenomena such as diffusion, absorption, liquid-liquid and solid-liquid extraction, distillation, decantation, filtration, and centrifugation.
      - Apply the concepts of chemical equilibrium, including phase equilibria and solubility equilibria, to select appropriate solvents and understand separation processes.
      - Analyze separation systems using macroscopic balances such as mass and energy balances, and interpret operating curves and equilibrium diagrams.

- Solve problems related to countercurrent absorption of a component using algebraic and graphical methods to determine optimal operating conditions.
- Understand distillation methods for separating binary and multicomponent mixtures, and solve distillation problems using algebraic and graphical methods.
- Apply knowledge of liquid-liquid phase equilibria to optimize separation processes and solve problems related to liquid-liquid extraction using algebraic and graphical methods.
- Understand the mechanisms of liquid-solid separation and the fundamental equations for sizing industrial equipment used in this separation.
- Master the theoretical principles of decantation, including the limiting settling velocity of particles, and size continuous decanters.
- Acquire an understanding of the basic principles of filtration, including solid support filtration and membrane filtration, and apply these techniques to real-world examples.
- Understand the effects of centrifugal force and centrifugal pressure on filtration processes in centrifugation.
- Evaluate the characteristics and properties of solvents to choose the appropriate solvent for separation processes.

b. PIs addressed by the course:

PI	1.1	1.2	1.3
Covered	x	x	x
Assessed	x	x	x

7. Brief list of topics to be covered

- Review of basic concepts and prerequisites: equilibrium, thermodynamic principles, and mass balances.
- Absorption
- Introduction and design of tray columns.
- Distillation
- Solid-liquid extraction.
- Liquid-liquid extraction and design of packed columns.
- Filtration and reverse osmosis.
- Decantation
- Centrifugation.