# Ideal and Non-ideal Reactors

1. **Course number and name:** 020RNICS2 Ideal and Non-Ideal Reactors

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

3. **Name of instructor:** Jihane Rahbani

4. **Instructional Materials:**
   - Elements of Chemical Reaction Engineering, Fourth Edition, by H. Scott Fogler.
   - Réactions et réacteurs chimiques; Cours et exercices corrigés; Michel Guisnet, Sébastien Laforge, Dominique Couton

5. **Specific course information**
   a. **Catalog description:**
   Material balances on ideal reactors: closed reactor, open stirred reactor, piston reactor. Conversion and reactor sizing. Stoichiometry of flow systems. Gas phase reactions. Multiple reactions. Energy balances in ideal reactors: closed reactors, open reactors in steady state. Real flows in reactors. Residence time distribution. Measurement of RTD: tracer method. Diagnosis of reactor malfunction. Modeling of non-ideal reactors: cascade of perfectly mixed tanks model. Axial dispersion model. Models with adjustable zero parameters. Practical work.

   b. **Prerequisites:** 020CIHNI4 Kinetics of Chemical Reactions; 020BMECS1 Mass and Energy balances

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

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   - Recognize the different types of ideal reactors.
   - Apply the laws of conservation of mass and energy to establish material and heat balances in ideal reactors.
   - Calculate reaction conversions, reaction rates and yields for ideal reactors.
   - Evaluate the performance of ideal reactors in terms of productivity, efficiency and selectivity.
   - Calculate heat fluxes, temperatures and enthalpies in ideal reactors.
   - Understand the limitations of ideal reactors and differences from real reactors.
   - Describe the cumulative functions F(t) and external age E(t) and residence time distribution.
   - Recognize these functions for PFR and CSTR reactors.
   - Apply these functions to calculate conversion and reactor outlet concentrations using the segregation model and the maximum mixing model.
   - Apply the perfectly stirred series reactor model and the dispersion model to tubular reactors.
   - Suggest ideal reactor combinations to model a real reactor.

**b. PIs addressed by the course:**

| **PI** | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 |
|---|---|---|---|---|---|
| **Covered** | x | x | x | x | x |
| **Assessed** | x | x | x | x | x |

**7. Brief list of topics to be covered**

- Definitions
- Types of reactors
- Writing of the material balance on a volume of the reactor
- Application to different types of reactors
- Association of reactors (in series and in parallel)
- Conversion and reactor sizing.
- Stoichiometry of flow systems.
- Gas phase reactions.
- Multiple reactions.
- Heat balance of ideal reactors
- Flow in the reactors
- The distribution of residence times
- DTS measurement: tracer method - Pulse injection
- Step injection
- DTS Moments
- DTS in ideal reactors
- Diagnosis of the malfunction of a reactor
- Model of perfectly agitated tanks
- Axial dispersion model
- Segregation model
- Maximum mix model

Practical Work:

- Polyvalent reactor: - Study of heat transfers- Material balances
- Plug flow reactor:
  - Flow pattern characterisation - Step change
  - Flow pattern characterisation - Pulse change
  - Conversion experiment