Energy Optimization

1. **Course number and name:** 020OEPES5 Energy Optimization

2. **Credits and contact hours**: 4 ETCS credits, 2x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Chantal Maatouk

4. **Instructional Materials:** PowerPoint slides - Professor textbook

   Textbooks/References:
   - Pinch Analysis and Process Integration. Ian C. Kemp. Second edition.
   - Intégration énergétique des procédés industriels par la méthode du pincement. Collection Ravel indusrtie.
   - Introduction to Pinch Technology. Linhoff March 1998.

5. **Specific course information**
   a. **Catalog description:**
   This course will examine the energy audit methods for industrial processes and the systematic mathematical methods of energy efficiency and energy, economic and environmental optimization of these processes by the application of the pinch method. The pinch method is a relatively recent method (it dates back to the 1980s), which makes it possible to determine the most efficient network of heat exchangers and utilities in an energy installation or an industrial process. It is based on thermodynamic principles and on the study of the thermal heat transfer between the streams to be cooled (availability) and heated (needs). It makes it possible to minimize the internal irreversibility of the heat exchanger network, and thus to improve its performance.

   b. **Prerequisite:** Heat Transfer (020TRCES2).

   c. **Selected Elective** for ME and EE students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   A student who successfully fulfills the course requirements will have demonstrated an ability to:
   - Realize an energy audit of industrial processes and analyze the energetic and economic data of these processes.
   - Understand the challenge of energy saving measures applied to energy processes.
   - Optimize an industrial process without making any apriorism on the configuration of the heat exchanger network.
   - Apply the pinch method to an industrial process that reduces both investment and operating costs.

- Quantify technically the feasible energy savings and determine their impact on energy efficiency of the process.

b. PI addressed by the course:

PI	1.2	1.3	4.2	7.1	7.2
Covered	x	x	x	x	x
Assessed	x	x	x	x	x

7. Brief list of topics to be covered

- **Course introduction** (1 Lecture).
- **Key concept of pinch analysis**. Basic concepts of heat exchange; the temperature-enthalpy diagram; composite curves; a targeting procedure; the grand composite curve. The pinch and its signification. The methodology of pinch analysis (4 Lectures).
- **Data extraction and energy targeting**. Data extraction; heat and mass balance; stream data extraction; calculating heat loads and heat capacities; choosing streams; mixing; heat losses, case study (4 Lectures).
- **Utilities, heat and power systems**. Concepts: Types of heat and power systems; Basic principles of heat engines and heat pumps; appropriate placement for heat engines and heat pumps. CHP systems: Practical heat engine; Selection of CHP system; refinement to heat and power systems; economic evaluation; Organic Rankine Cycle. Heat pumps and Refrigeration systems: Heat pump cycles; refrigeration systems. Cooling water systems, case studies and examples (7 Lectures)
- **Heat Exchanger Network design**. Heat exchange equipment. Types of heat exchanger; Shell and tube exchanger; plate exchanger; recuperative exchanger. Heat recovery to and from solids. Multi-stream heat exchanger. Stream splitting and cyclic matching. Network relaxation. Multi-pinches and near pinches. Retrofit design. Network design for organics distillation case study (4 Lectures).
- **Economical study of integrated industrial process**. Targeting heat exchanger units, area and shells: Targeting for number of units. Deviations from pure counter-current flow. Cost targeting for optimal Pinch. Tradeoffs in choosing pinch value (2 Lectures).
- **Case study**. Energy targeting; Area targeting; Cost targeting; Zonal targeting; Targeting with utility streams included (2 Lectures).