Course Syllabus

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

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

3. Instructor's or course coordinator's name: Chantal MAATOUK

4. Text book :
    a. other supplemental materials:
    Professor text book and other supplemental materials
    Pinch Analysis and Process Integration. Ian C. Kemp. Second edition.

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 fluids to be cooled (availability) and heated (needs). It makes it possible to minimize the internal irreversibilities of the heat exchanger network, and thus to improve its performance.

    b. prerequisites : Applied thermodynamics

    c. Required/Elective/Selected Elective: Selected Elective.

6. Specific goals for the course
    a. specific outcomes of instruction,

- 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. KPIs addressed by the course.

KPI	a2	b3	e2	e3	h1	k3
Covered	x	x	x	x		
Assessed	x	x	x	x	x	x
Give Feedback		x	x	x	x	x

7. Brief list of topics to be covered and approximate lecture hours :
   - Course introduction, (1 Lecture)
   - Chapter 2- 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)
   - Chapter 3- 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, (3 lectures).
   - Chapter 3- Case study: Organics distillation plant. Process description; Heat and mass balance; stream data extraction, (1 lecture)
   - Chapter 4- 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; Shaft work analysis; Cooling water systems, (5 lectures)
   - Chapter 4- Case studies and examples. Whisky distillery; CHP with geothermal district heating; Hospital Site, (3 lectures)
   - Chapter 5- Heat Exchanger Network. 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, (2 lectures).
   - Chapter 5- Stream splitting and cyclic matching: Stream splitting; Cyclic matching; design away from the pinch. Network relaxation: Using loops and paths; Network and exchanger temperature difference; Alternative network design and relaxation strategy. Multi-pinches and near pinches. Retrofit design. Network design for organics distillation case study, (5 lectures).
   - Chapter 6- Economical study of integrated industrial process. Targeting heat exchanger units, area and shells: Targeting for number of units; targeting for minimum number of units; Area targeting; Deviations from pure counter-current flow; Number of shell targeting. Supertargeting: Cost targeting for optimal Pinch; Trade offs in choosing pinch value; Illustration of two-stream example; Factors affecting the optimal pinch, (2 lectures).
   - Chapter 6- Case study: Energy targeting; Area targeting; Cost targeting; Zonal targeting; Targeting with utility streams included, (2 lectures).