CHE 551 Advanced Topics In Chemical Engineering
"Energy Optimization Using Pinch Analysis"
Chemical Engineering Department, King Saud University
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Fall Semester, 1425 H

# Midterm Exam

**Q1 a.** Find the minimum utility requirements for a network of heat exchangers involving the following streams:

| Process Steam | Temperature, °C Supply | Target | Heat-Capacity Flow Rate, *CP* (kW/°C) |
|---|---|---|---|
| 1 | 100 | 430 | 1.6 |
| 2 | 180 | 350 | 3.27 |
| 3 | 200 | 400 | 2.6 |
| 4 | 440 | 150 | 2.8 |
| 5 | 520 | 300 | 2.38 |
| 6 | 390 | 150 | 3.36 |

The minimum approach temperature, $\Delta T_{min}$ is 10 °C.

**b.** For (a), position the heat exchangers so as to achieve a network that requires the minimum utilities.

**Q2** Consider the following streams:

| | $T_s$(°C) | $T_t$ (°C) | *CP* (kW/°C) |
|---|---|---|---|
| H1 | 350 | 160 | 3.2 |
| H2 | 400 | 100 | 3 |
| H3 | 110 | 60 | 8 |
| C1 | 50 | 250 | 4.5 |
| C2 | 70 | 320 | 2 |
| C3 | 100 | 300 | 3 |

When $\Delta T_{min}$ = 10 °C, the minimum utilities for heating and cooling are 237 kW and 145 kW, respectively, and the pinch temperatures for the hot and cold streams are 110 °C and 100 °C, respectively.

Design a network of heat exchangers that has the minimum utilities for heating and cooling. Match the streams *to avoid stream splitting*.

Show the heat duties and temperatures for each heat exchanger.