PROCESS DESIGN AND INTEGRATION
(4 ECTS credits) *Compulsory*

Responsible person:

Jan Górski, D.Sc., Assoc Prof.

Learning outcomes:

This course is focused on the selection of processing steps and their interconnection into a complete system to transform materials into final products. The course will deliver effective tools for integration and optimisation of unit chemical processes. It will provide the design of effective processes which will achieve savings on cost, energy usage and emissions. The aim of this course is to give the students a better understanding the technical aspects and new tools for better planning the future and more clean technologies based on accessible resources and effective coupling the unit operations. Students develop valuable skills, including use of design and modelling software such as Matlab, Hysys, ChemCAD and AspenPlus.The lab portion of the class provides the students with working experience and applications on computer-aided simulation of chemical engineering systems.

By the end of the courses, the students should be able to perform the following:

Evaluate overall mass targets (fresh usage, waste discharge, yield, etc.) for a given process
Manipulate design and operating variables to optimize process performance
Synthesize direct recycle networks
Screen and synthesize networks of mass exchangers
Evaluate targets for minimum heating and cooling utilities
Screen and select mass and heat utilities
Use ASPEN Plus to simulate various scenarios of units and groups of units.
Also, use simulation to analyze process performance, identify opportunities, troubleshoot problems, and recommend changes
Apply different techniques to estimate fixed cost, operating cost, and profitability criteria
Prepare a typical design report.

Course main content:

The course is built of two main parts:

Part 1: First part consists of 20 hours of lectures

This course is intended to introduce students to the fundamentals and applications of process design. In particular, the course presents systematic process-integration tools for the synthesis, development, and screening of potential process flow sheets. The course also reinforces equipment design of common process equipment. Practical problems are used as examples. These problems cover general classes of topics in the areas of mass integration, heat integration, separation processes and environmentally benign and inherently safe designs.

Lectures will concern the following subjects:

Introduction to process design (process analysis and simulation, synthesis and optimization, equipment selection and design, process integration)

Analysis of mass and energy flows (substance, energy and exergy balances)

Mass and energy integration (thermodynamic, design, and economic-optimization aspects, targeting process performance, pinch-point analysis)

Detailed design and optimization of heat exchangers and energy conversion equipment
Process economics and environmental aspects.

Part 2: Computer laboratory- project

These PC laboratory exercises are carried out by groups of two students each. By this the students are able to practice with the engineering software tools (Testherm, ASPENPlus, Matlab, Thermofluids and others), and solve some applied problems such:

1. Prediction of thermodynamic and transport properties and balancing example processes
2. Computer simulation and control of selected reactions chemical kinetics
3. Optimization techniques – methods and practical application example
3. Heat exchanger (HEX) design - Analysis of heat and mass transfer processes
4. Application the "Pinch Point" method for optimization of HEX's system.

In this part each student will prepare an individual project (topics for analysis the other particular cases are accessible for demand).

In the preparatory period the students are consulted (on campus or, on demand by distance e-learning). Class updates and frequent announcements regarding class meetings, homework, and exams will be transmitted via email. The main topics on teaching material will be available at the following website: http://home.agh.edu.pl/~jgorski

Admission requirements:

bachelor's work must be completed; basic knowledge of: thermodynamic and fluid mechanics, heat and mass transfer, chemistry or chemical process engineering, mathematics and IT including numerical methods and basic engineering software use.

Literature:

1. Smith, R.: Chemical Process: Design and Integration. J. Wiley & S., New York, 2005
2. Babu B.V.: Process Plant Simulation. Oxford Univ. Press, 2004
3. Sieniutycz S., Jeżowski J.: Energy Optimization in Process Systems. Elsevier Ltd., 2009
4. Bejan A.: Entropy Generation Minimization. CRC Press, Boca Raton, 1995
5. Kemp I.A.: Pinch Analysis and Process Integration. Butterworth-Heinemann, 2007

Examination:

A written test at the final meeting in classroom lectures.
Individually prepared and accepted project.
The final grade will be averaged between credits obtained from the main two parts of the course.