Chemical and Biochemical Engineering 428 (14:155:428)
Chemical and Biochemical Engineering Design and Economics II
Spring 2014 (4 credits)
Lectures: Monday, Wednesday 1:40 – 3:00pm, SEC-209
Recitation: Wednesday 12:15 – 1:10pm, SEC-210

Instructor: Professor Fuat E. Celik (C-215 Engineering, 5-5558, fuat.celik@rutgers.edu)
Office hours: Monday, Wednesday 3:00 – 4:00 pm, and by appointment

TA: Sebastian Escotet (C-156 Engineering, sebastianescotet@gmail.com)
Office hours: Wednesday 10:00 – 12:00 am and by appointment
TA office hours in Microlab I

Course info: https://sakai.rutgers.edu

Text: M. S. Peters, K. D. Timmerhaus, R. N. West, Plant Design and Economics for Chemical Engineers, 5th Edition, McGraw-Hill Book Company, New York (2003).

Class meeting times: Due to the computational nature of the course, most recitations and Wednesday lectures will take place in the EIT Lab (D-110 Engineering), unless otherwise announced.

Monday 1:40 – 3:00pm, SEC-209
Wednesday 12:15 – 1:35pm, EIT Lab (D-110)
Wednesday 1:40 – 3:00pm, EIT Lab (D-110)

For Wednesdays, the class will be split into two sections, one starting at 12:15 and one starting at 1:40. The objective is to have enough PCs in class for each student. Please sign up for a section during the first class(es), and try to sign up together with your project group.

Software and computers: You will use Aspen suite of process design and analysis software for the design project. Aspen is currently installed in Microlab I and Microlab II (C-233, C-241), DSV (B-125), and EIT (D-110) computer labs.

Aspen installation thumb drives/DVDs are available for you to install Aspen on your personal Windows computers for the duration of the semester. You will configure Aspen to connect to the on-campus license server for authentication.

Course description: Design and economics of large chemical/biochemical plants. The design details and economic considerations involved in the design, construction, and operation of chemical/biochemical plants using basic principles and modern computer software.

Course objectives: This is the capstone course, which utilizes the fundamentals of chemical and biochemical engineering (material balances, energy balances, transport phenomena, thermodynamics, kinetics, separations, unit operations, control, and safety) in the design and operation of chemical/biochemical plants. The course introduces the concepts and methods of plant design and economic evaluation: planning, cost estimation, fixed capital investments,

working capital, production costs, depreciation, rate of return, profitability analysis, discounted cash flow analysis. Students will use state-of-the-are computational tools for process flow design and economic evaluation.

The expectation for this design project is each team will assemble a **working simulation** of a chemical process plant of **their own design** for the topic selected. That Aspen process flowsheet will model the unit operations necessary to convert raw materials into finished products. To the greatest extent possible, the models for the unit operations must be physics- and chemistry-based, and all models must operate within the limitations of what is feasible in the real world. This requires understanding how the real world processes work, understanding how Aspen works, and fitting the available Aspen models to the real world processes in the simulation.

Prerequisites:
14:155:324: Design of Separation Processes
14:155:415: Process Engineering I
14:155:427: Chemical and Biochemical Engineering Design and Economics I
This is a required course in the Chemical and Biochemical Engineering curriculum.
Course grade:

- Design Memos 20%
- Oral Presentation 1 10%
- Written Report 1 20%
- Oral Presentation 2 20%
- Written Report 2 20%
- Exam 10%

Design Memos: In-class assignments will consist of design memos – short team problem solving activities on chemical engineering design. Teams will be randomly assigned. Each team will select a team leader, who will write up the memo (normally collected at the end of class). Each student should act as team leader at least once in the semester.

You are allowed one unexcused absence from a Design Memo throughout the semester. If you do not miss any Design Memos, your lowest Design Memo Grade will be dropped. You must be in class during attendance in order to receive credit for the Design Memo

Design Project: The focus of the course is design, cost estimation, and profitability analysis of a complete chemical/biochemical process plant that you selected in the previous semester. Together with your group, you will work jointly in carrying out the technoeconomic analysis, including material and energy balances and plant economics, and prepare the final report.

The following are critical to your success in this course:

1. Begin early and work at a steady pace. The project is a significant time requirement and you will accomplish more by working on it every week.

2. Act as a team. The project has several components and steps. It is best for all team members to contribute to each stage of the project and be knowledgeable of the overall process. Consider assigning each team member one or two sections of the process flow sheet so that each member gets experience with Aspen, cost estimation, plant design etc.

3. Use every resource. Utilize the textbook, the handouts, the library, the computer, the assistant, and the professor as sources of information for this project.

4. Communicate early and often. If you have questions or difficulties with any aspect of the course or project, communicate with Prof. Celik as soon as possible so solutions can be sought.

Oral Presentation 1: Each group will present their process flow diagram and mass and energy balances to the instructor and TA. Presentations will take place Wednesday, March 5th and Monday, March 10th.

Written Report 1: Material and Energy Balances. The most important element of the first written report is the process flow diagram, including mass and energy balance, and atom balances on the overall plant. The plant design should be nearly finalized as of this report. The report should include a description of each process island and a summary of the design strategy (for each process unit and how they are arranged). Process variables should be summarized as tables. Stream tables should be included in the appendices. Written Report 1 is due at 5pm on Friday, March 15th.

Oral Presentation 2: Each group will present their overall plant design, material and energy balances, and process economics to the class. Presentations will take place between April 16th and April 30th.

Written Report 2: The final report is a comprehensive report and includes the material and energy balances as well as the plant economics. This report will include a revised version of the first report. The final written report is due at 5pm on Friday, May 2nd. (Early submissions are ok)

Exam: For the exam, you will write a summary (minimum 2 pages) of your team's design project, your role in the ASPEN simulation, cost analysis, and preparation of the final report, and a short description of what you learned in the class. You will also draw a block-flow diagram summary of major process islands/units. The exam will be closed book and closed notes, no electronics. The exam will take place in class on Monday, May 5th.