Chemical and Biochemical Engineering 427-428 (14:155:427/428)
Chemical and Biochemical Engineering Design and Economics I
Fall 2017 (3 credits) **Spring 2017** (4 credits)

Fall Lectures: **Monday 5:00 – 6:20 pm (BME-102)**
Thursday 5:00 – 6:20 pm (FBO-EH AUD)

Instructor: Professor Fuat E. Celik (C-215 Engineering, 5-5558, fuat.celik@rutgers.edu)
Office hours: Monday 3:30 – 5:00 pm
By appointment
After class

TAs: Ou Yang (oy21@scarletmail.rutgers.edu)
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Kien Chau (kchau926@yahoo.com)
Office hours: @ C-254 Tuesday 1:30 – 3:30 pm
@ C-254 Friday 1:30 – 3:30 pm

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

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

Software & computers: For both parts of the course, you will use the aspenONE suite of process design and analysis software (which includes ASPEN PLUS and cost estimation software), currently installed in Microlab I and Microlab II (C-233, C-241), DSV (B-125), and EIT (D-110) computer labs. Additionally, you will also use Microsoft Excel and MATLAB.

ASPEN PLUS installation files and instructions are available on Sakai under resources. You may install the aspenONE software suite (including ASPEN PLUS) on your personal Windows computers for the duration of the academic year. You will configure ASPEN PLUS to connect to the on-campus license server for authentication. (Note: Although not officially supported by Aspen Technology on Windows10, aspenONE software suite can be configured to run on Windows10, including Windows emulation of Mac computers.)

Course description: This is a two-semester course (155:427 & 428) that covers the principles of process and product design, and economic considerations for building and operating chemical or biochemical plants, employing engineering 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-art computational tools for process flow design (steady-state process simulation) and economic evaluation.

The expectation for this design project is that 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:
14:155:303: Transport Phenomena in Chemical Engineering I
14:155:307: Chemical Engineering Analysis II
14:155:324: Design of Separation Processes

Discussion Forum: This course will include the discussion forum feature available in Sakai for answering routine course and project related questions. All such questions should be addressed to the relevant thread in the forum, where the instructor or assistants will answer them, and all students will have access to the questions and answers. Students are encouraged to ask questions in the forum and answer each other's questions.

E-mail should only be sent to the instructor for personal matters. All course-wide matters and questions should be directed to the forum.

Team Communication: Design project teams are required to communicate with each other via email, just as within a workplace setting. E-mails should be written professionally. SMS text messages between team members will not be considered within the context of course requirements.

Course grade:

- Design project
  - Written Report 30%
  - Oral Presentation 40%
- In-Class Design Memos 30%

Grades for assignments will be uploaded to the "Gradebook" section of the Sakai site. This is for informational purposes, and only the weighting above will be used for determining the course grade.

Late assignment policy: Late assignments will not be accepted, including delays caused by failing to upload submission files to Sakai properly or on time.

Design Project: The focus of the course is design, cost estimation, and profitability analysis of a complete chemical/biochemical process plant. 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.

Teams: Design project teams will be formed using the CATME survey tool based on schedule availability and to a lesser extent other factors. Teams will be assigned, and special requests to be placed on specific teams cannot be granted. Teams are subject to change based on team cohesion and contribution at the sole discretion of the instructor, with input from CATME peer evaluations.

Written Report 1: Literature review and block flow diagram: You will prepare a properly cited document detailing the real-world operation of the different technologies you will use in your processes. Be as specific as possible. You will organize the discussion with the help of a preliminary block flow diagram that will lay out the major process unit operations of your plant. It is not necessary to discuss the simulation of the processes at this point. Written Report 1 is due (on Sakai) at 11:50 pm on October 16th, 2017.

Oral Presentation 1: Material and Energy Balances. The most important element of the second deliverable is the detailed process flow diagram, including mass and energy balances, and atom balances on the overall plant. This report will detail the Aspen simulation strategy that you have used to capture the real-world processes described in the first report.
The plant design will be preliminary as of this report. You will be responsible for having realistic models of your major process equipment.
The oral report should include a description of each process island and of the design strategy (for each process unit and how they are arranged).

Each group will present their real-world process and their simulation to the class. Presentations will take place beginning mid-November, 2017.
Each team must upload their ppt/x file to sakai no later than 11:50 pm the night before their presentation date.

Written Report 2: The final report is a comprehensive report and includes the material and energy balances as well as the plant economics. The final written report is due at 11:50 pm on March 7th, 2018.

Oral Presentation: Each group will present their real-world process and their simulation to the class. Presentations will take place beginning April, 2018.
Each team must upload their ppt/x file to sakai no later than 11:50 pm the night before their presentation date.

Design Memos: In-class assignments will consist of design memos – short team problem solving activities on chemical engineering design. These design memos will develop teamwork

skills, illustrate chemical engineering design principles, and promote thinking with a design mindset.

Teams will be assigned. Each team will select a team leader, who will write up the memo (normally collected at the end of class). You must be in class during attendance in order to receive credit for the Design Memo.

General advice

The following are critical to your success in the design project and the course:

1. Begin early and work at a steady **pace**. The project is a significant time requirement and you will accomplish it only 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. Utilize the textbook, the handouts, the library, the computer, the TAs, LAs, 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. If you have any questions or concerns regarding your teamwork dynamic, you must bring them to my attention immediately.

5. Use the **forum** to communicate with the instructor and assistants, and each other. Usually you are not the only one asking the same question. Post your questions with easy to understand titles so your classmates can find them.

6. Your **team effectiveness** will be evaluated using CATME tools and poor contribution to your team's effort will negatively impact your grade.

7. **Dishonest** peer evaluations, regarding your own or a teammate's work contribution will be treated as an academic integrity violation and will be submitted to the Office of Student Conduct for investigation. A Conduct Officer will determine which members of the team, if any, submitted dishonest peer evaluations and will determine the appropriate action.

8. All submitted work will be submitted to Turnitin service for **plagiarism** checking. All instances of plagiarism will be will be treated as an academic integrity violation and will be submitted to the Office of Student Conduct for investigation. A Conduct Officer will determine which members of the team, if any, were involved in plagiarism and will determine the appropriate action.

9. Take **notes**. This is not a chalkboard lecture class, but important information about the course and projects will be given in advance of you implementing it in the projects. Take notes on any material presented in class to make sure you don't miss anything.

10. **Attendance** is important and mandatory. Attendance will be taken for all Design Memos. If you will miss a design memo date, you must contact the instructor in advance. Same-day notification will not be accepted unless there is a medical or family emergency (with evidence). Advance notification will be given alternate assignments to complete.