Otto H. York Department of Chemical Engineering
ChE 472 Process and Plant Design

Catalog Description:

Course: ChE472 is the Capstone course in Chemical Engineering. Generally, this course can involve process design, product development or both depending on the specific project(s) under consideration. Each student will be expected to bring all the knowledge acquired in their previous courses (math, physics, chemistry, unit operations, reaction engineering etc.) and will be held responsible for reviewing concepts that were unclear prior to ChE472.

Textbook(s):

Process Simulation Tool: Aspen plus (latest version)

Course Management Tool: Moodle (http://moodle.njit.edu/)

Prerequisites by topic:

- Material and energy balances
- Fluid flow
- Heat and Mass Transfer
- Separations
- Reaction Engineering
- Thermodynamics
- Process Safety Fundamentals
- Chemical Process simulation techniques
- Ability to communicate (oral and written) technical concepts
- Economics

Course objectives:

1. Design a given process (or parts of) including the selection of processing equipment and material of construction.
2. Perform capital and operating cost analysis (cash flow, profitability analysis etc.) for a given project.
3. Optimize the given process to achieve most profitable design.
4. Project management/work in teams.
5. Prepare weekly progress design report memos.
6. Deliver successful written report and oral presentations that communicate technical results from a given process design project.
7. Evaluate a process’s safety, health (www.sache.org) and environmental impacts. (green engineering)
## Course Objectives - ChE 472 Process and Plant Design

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<th>Objective 1: Design a given process (or parts of) including equipment/line sizing and material of construction selection</th>
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<td>Strategies and Actions</td>
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<td>Design of equipment, Analysis of performance of equipment, Understand interrelationship between equipment in process</td>
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### Objective 2: Perform capital and operating cost analysis

| Perform capital cost estimation and annual operating cost | Students will be able to do economic analysis based on the calculated capital cost estimation and annual operating cost | c, k | 2 | Final report and assessment rubric. In-class group activities |

### Objective 3: Optimize the given process to achieve most profitable design

| Apply economic, physical constraints and optimization methods to obtain solution | Understanding of interrelationship between equipment in the process, economic analysis, process/equipment constraints, and optimization methods to obtain optimum solution. | a, c, e, k | 3 | Final report and assessment rubric. In-class group activities |

### Objective 4: Project management/work in teams

| Resolve complex problem into components by defining project schedule/deliverables | Ability to manage the main tasks and project scheduling while learning to work in teams. | d, f, g | 4 | In-class group activities, and assessment rubric (student questionnaire) |

### Objective 5: Prepare weekly progress design report memos

| Prepare weekly progress design report memos | Ability to prepare short design report of tasks completed in a weekly basis | c, d | 5 | Weekly design reports |

### Objective 6: Deliver successful written report and oral presentations that communicate technical results from a given process design project

| Prepare a written design report | Students will be able to prepare a written process design report document. | c, d | 6 | Final Design Report |
| Give an oral presentation of the given process design | Students will be able to deliver oral presentation of the given design project | d, g | 6 | Preliminary and Final Oral Presentation |

### Objective 7: Process Safety & Environmental

| Application of process safety & environmental principles and some other global, societal, legal aspects | Students will be able to apply process safety and environmental principles to the process design. | c, f, h, i | 7 | Final Design Report |
**ABET Outcomes**

a. Ability to apply mathematics, science and engineering principles.

b. Ability to design and conduct experiments, analyze and interpret data.

c. Ability to design a system, component, or process to meet desired needs.

d. Ability to function on multidisciplinary teams.

e. Ability to identify, formulate and solve engineering problems.

f. Understanding of professional and ethical responsibility.

g. Ability to communicate effectively.

h. The broad education necessary to understand the impact of engineering solutions in a global and societal context.

i. Recognition of the need for and an ability to engage in life-long learning.

j. Knowledge of contemporary issues.

k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.
Projects: There will be TWO projects consisting of multiple modules

Read the following chapters: 18 – 24.

Weekly objectives will be posted on moodle (http://moodle.njit.edu/) unless otherwise stated by the instructor.

Final **individual** Grades will be awarded according to the following averages:

- A = 85 and above
- B+ = 80 - 84
- B = 75 - 79
- C+ = 70 - 74
- C = 65 - 69
- D = 60 - 64
- F = 59 and below

*Notice that there will be grey areas in the grades, your final grade will depend on whether you are progressing or digressing.*

Class assignments will include peer assessment of individual performances on team projects, class participation and problem solving.

*Weekly Design Memorandum to report group work progress and team members participation is a must.*

Project Grading will be heavily based on the effective and judicious use of AspenPlus, for example:

- Drawing block flow diagrams
- Entering components appropriately
- Entering conditions/stream properties correctly
- Selecting appropriate thermodynamic/physical properties method(s)
- Selecting appropriate solution method(s)
- Obtaining **not just converged, but correct/appropriate solutions** for a given problem
- Be able to access results on demand
- Present (written and oral) overall stream tables using requested units of measurement
- Develop process flow diagrams
- Develop economic assessments for a given process
- Develop excel spreadsheets to perform required relief valve and equipment sizing/cost calculations **that also function as a calculation procedure report**
- Develop excel spreadsheets to tabulate and plot Aspen results to facilitate presentation and analysis of results
- **Provide weekly written report summaries**
A final project report will consist of (report format given in project statement & Section 26.1):

1) A Process Flow Diagram (PFD)
2) A Material and Energy balance sheet (stream table)
3) Solution output from Aspen plus (zipped Aspen input and output files)
4) Economic evaluation of the process (submit excel files)
5) Calculation blocks parameters (heat exchanger, reactor, separations etc.)
6) Equipment Sized Summary Tables
7) Line Sizing Summary Tables
8) Utilities Consumption Summary Tables
9) A statement on green engineering for this process (how the process might be improved, environmental impact from the compounds used etc)
10) Safety related issues; www.sache.org (can obtain certification here)
11) An appendix containing sample calculations (vessel sizing, relief valve sizing, etc.), data used, derivations, graphs, and tables

Remarks!
1) Other standard software (Visio, Word, Excel, AutoCAD etc.) may be employed to draw flow diagrams or perform calculations but must be documented and accessible to the instructor.
2) Points will be deducted for late submissions at a rate of 10% per day for a given assignment.
3) Wrong or inappropriate units will be treated as if the associated problem solution is incorrect.

Because class periods will be working design sessions, you will need to bring your textbook (have alternate resources) to class.

Academic Policy on Cheating/Plagiarizing will be in effect; please note that the first offense will be dealt with severely and the 2nd offense will earn you an F in the course for the semester. Also note that subcontracting of assigned work will be treated as cheating in this course!

Please refer to:
http://www.njit.edu/academics/provost/docs/Best_Practices_related_to_Academic_Integrity.pdf

Must Read: pages 24 -31 of text on ENGINEERING ETHICS