Capstone Design Project

CHE / MSE 482, 3 (6 laboratory hours) credits
Spring Semester 2015

Wednesday, 12:00 – 1:00PM LME 316
Wednesday, 1:00 – 2:15PM SFB 103
Wednesday, 2:30-3:45PM PE 205
Wednesday, 4:00-5:15PM OB 101
Wednesday, 5:30-6:45PM OB 101
Friday, 12:00 – 1:00P SEM101

Instructor

Dr. Alan Fuchs, LME 307, 327-2227, afuchs@unr.edu
Office Hours: Weds, 10:30AM-11:30AM

Textbook


Prerequisites

Process Design I (CHE 450), Reactor Design (CHE 440).

Catalogue Description

Individual projects in the design of processes and plant components including safety, social and ethical considerations.

Educational Objectives

These are listed in the Course Outcomes section at the end of the Syllabus. The outcome which applies to the Silver Core is CO – 14 (Application).

How this course will satisfy the Core Objectives:

CO-14 (Application): Applications are carried through collaboration with industries including: Genentech, Barrick and Micromidas. The focus of this class is solving engineering problems. Chem Cad and other computer tools are used as part of this class. This includes understanding the principles of process design and synthesis – process flow diagrams, block diagrams and process and instrumentation diagrams, batch vs. continuous, process recycles and bypasses, conditions of special concern. In the Spring
semester students carry out the design project with industry partners. Design parameters and performance equations are evaluated and process economics and profitability are assessed.

**CO14** learning will be evaluated through specific assignments and projects that address the topic of application and help gauge student understanding of the issues as they relate to the profession of engineering. Student performance data for these metrics will be recorded, analyzed, and reported as required.

**How Student Learning Related to the Core will be Assessed:**

Student learning will be assessed by weekly student presentations given in class related to the Design projects, with feedback from students and the instructor. At the end of the semester the students will travel to our industry partners and make their final presentations and receive feedback from our partners. Honor’s projects include entry into the Nevada Governor Cup.

**Educational Learning Objectives:**

In this course you will apply the principles of design in order to accomplish the tasks necessary to compete in a national design competition. This will require application of all of the concepts learned in the first 3.5 years of the B.S.ChE curriculum. Students will master the following topics:

1) Design a chemical process selected by each team, and prepare a block flow diagram (BFD), process flow diagram (PFD) and piping and instrumentation diagrams (P&ID).
3) Utilize team work and project management skills.
5) Prepare a literature review and investigate engineering economics and scale-up considerations.
2) Show understanding of environmental, health and safety issues.
4) Describe the detailed design of the chemical process selected by each team, and prepare a poster, a paper, and an oral presentation describing the process design.
4) Describe detailed equipment design and possible experimental design considerations.

**Weekly Progress Reports**

The homework assignments for this course will be oriented toward planning and preparation for the external presentations at the partner companies / organizations and the Governor’s Cup (for extra credit and Honor’s Thesis). Assignments will be in the form of weekly progress reports and Powerpoint presentations, which will describe the objectives, approaches and detailed plans of how to achieve the proposed objectives. This will require careful planning of the detailed designs to be carried out. At the conclusion of each week’s work, a written progress report or Powerpoint presentation will be submitted by each team member.
Progress reports and presentations documenting new literature review, equipment design, modeling results and analysis of these results are required to be handed in each week on Friday by 5PM (they can be put in my mailbox). Each group will alternate between writing a report and two Powerpoint presentation according to the schedule given below. Powerpoints will be given a maximum of 5 points, reports 10 points. This report / presentation should include any new ideas or concepts relating to your project which you identify during the week. This might include new strategies for the project or important issues identified in the literature. In the past it has been found that the identification of these new ideas and communication of them to the rest of the group is critical to the success of the project. The literature reviews are critical to your understanding of the context of the project. When you find a new journal paper please write a paragraph or half page in your weekly report (or several bullets in your presentation) describing the important findings of the paper. Also mention how this information relates to your project.

The team leader is a rotating position and every student will have the opportunity to serve in this role. The team leader is responsible for identifying areas of responsibility for the team members and assigning them. Preliminary team member roles were identified last semester and serve as a starting point. This should be done during the first week of classes. Remember that you will all get a chance to be the team leader, so choose these assignments fairly, since you will be on both ends of this process. These assignments should be described by the team leader in a separate section of the first progress report of the semester and this portion of the progress report should be handed in every week (in report format not as part of the Powerpoint). The team leader will receive up to one point extra credit for the weekly report or PPT. In the past typical assignments included: Gantt Chart, literature review (this should include any relevant patents). The literature review should also include other methods that are currently available for solving the problem. The literature review citations should include: author name, “paper title”, journal name, volume, number, date), equipment design issues, modeling and simulation (Chem Cad process simulation may be appropriate here. This also includes mathematical models and their solutions to describe the process, identification of relevant engineering issues and quantification of them), review of literature experiments – data, process chemistry (or physics), analytical methods, technical issues relating to scale-up, full scale economics, recruitment of specialists and consultants to the project (this generally involves other faculty or graduate students at UNR who can contribute to your project by having occasional meetings with group members. Health and safety, legal issues, regulations, public involvement plan may be included. In the past some assignments have been made to multiple students (for example equipment design is usually done by several students together). The weekly reports / presentations should also include detailed design heuristics of equipment and a description of the equipment, a discussion of what data would be collected and how it would be collected and a description of what analysis would be done (analytical methods, etc.).

We will be visiting Genentech, Barrick, TMWRF and Micromidas. Deliverables for these activities include: Powerpoint Presentation, poster, and paper. These deliverables need to be assigned to the team members. Please begin working on these deliverables early,
target to have them completed two weeks before the due date, this will leave time for editing and review. Remember that the time and effort that you put into your weekly reports and PPTs will be useful later when you prepare these documents.

During the first week of the semester a Gantt Chart should be prepared by the team leaders for each group as part of the group report. This should include a detailed listing of the tasks to be carried out by each team member and the associated timeline.

This semester experimental work will be part of the project. You will need a safety audit before you begin any experiments in the lab. Mr. Mike Kivistic at EHS will do this audit.

Please keep in mind that these reports will be graded on the use of innovation and the application of engineering and scientific principles. Whenever you can use quantitative methods (equations, figures and tables) to prove your point it will make your argument stronger. **Please do not just hand in a simple description of the tasks that you carried out during that week.** Please consider the time commitment expected for this class each week. This is a 3 credit course. It is normally expected that 3-4 hours per credit hour are required outside of class time. This means that 9-12 hours are expected to be spent on this class outside of class time each week. This is an average value, so more may be required some weeks and less others. It is expected that weekly reports should take about 1 ½ - 2 hours per week.

Descriptions for the projects for 2015 are given as separate attachments in WebCT.

**Extra Credit Assignments**

There is also an extra credit assignment related to the Governor’s Cup. These include: an application to compete, paper, and if you are selected to compete, a Powerpoint Presentation (begin these deliverables early, target to have them completed two weeks before the due date, this will leave time for editing and review). Dr. Mark Pingle’s Entrepreneurship Club can also help find Business students. Recruitment of a Junior student into project team is recommended.

**Trips to Companies**

A trip will be planned to the companies with whom we are working this Spring. The visits will be toward the end of the semester. During the visit each team will present the results of their project. The team leaders are responsible for organizing the trips for that team. Organization of the trip involves interaction with the companies and scheduling the meeting. It also involves organizing the transportation and budget issues for the trips. These issues should also be described by the team leader in the weekly progress reports. This year the teams will also participate in Innovation Day. Details will be provided.

**Budget**
A budget of $500 for materials and supplies and travel costs for the teams should be prepared for each team (four teams total). The team leader should include this in the first weekly team leader report.

**Grading**

**Weekly Progress Reports / Presentations – 75%**  
**Participation – 10%**  
**Final Project – 15% (Report, Powerpoint, Poster, Final Check Out Form - signed by instructor)** Students must attend the external presentations in order to receive credit for the final project. Students must hand in check out sheet signed by instructor.

**Grading Policy**

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<thead>
<tr>
<th>Grade</th>
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<tr>
<td>A</td>
<td>90-100</td>
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<tr>
<td>A-</td>
<td>86-90</td>
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<tr>
<td>B+</td>
<td>83-86</td>
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<tr>
<td>B</td>
<td>80-83</td>
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<td>B-</td>
<td>76-80</td>
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<td>C+</td>
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<td>F</td>
<td>Below 60</td>
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**Academic Honesty Policy**

Academic honesty is one of the most important issues for engineering students. Students are encouraged to work together to enhance their learning experience. This might include discussions between one or more students about the conceptual issues and ideas related to the homework problems. This does not include exact copying of assignments or parts of assignments which is not permitted and would constitute the definition of plagiarism. Any copying of a homework assignment will result in a zero credit given for that assignment.

**Ability Resource Center**

"If you have a disability for which you will need accommodations, please contact me or Mary Zabel at the Disability Resource Center (Thompson Student Service - 107), as soon as possible to arrange for appropriate accommodations."
CHE / MSE 482 Course Outcomes

Students will be able to demonstrate:

(1) an ability to apply knowledge of mathematics, science, and engineering
   • Use the skill for all math, science and engineering classes in 3.5 years of CHE curriculum.
   • The design of the unit operations for each project is intensive in math, science and engineering. Projects are with Genentech, Barrick and Micromidas. The focus of this class is solving engineering problems. Students begin to plan the Spring semester design project during the first semester class. Chem Cad and other computer tools are used as part of this class. This includes understanding the principles of process design and synthesis – process flow diagrams, block diagrams and process and instrumentation diagrams, batch vs. continuous, process recycles and bypasses, conditions of special concern. Applications are carried through collaboration with the companies listed above.

(2) an ability to design and conduct experiments, as well as to analyze and interpret data
   • Each project has lab experiments which students design, run and analyze. In the previous semester of Capstone design the students planned for the experiments they will run in the second semester. Students utilize computer simulation techniques in design – chemical component / physical properties database, thermodynamic models, unit operations parameters, equipment topology and process optimization

(3) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
   • The focus of this class is design of systems, components and processes for many different areas.
   • Students design components and systems of: antibody plant, extractive metallurgy leaching plant, and biobased polymers. The focus of this class is design of systems, components and processes for many different areas.

(4) an ability to identify, formulate, and solve engineering problems
   • Students are required to do a literature search for their project proposal and need to seek other ways to develop their design project.
   • All of the design projects are on real world projects and students solve engineering problems. Students are required to do a literature search for their project proposal and need to seek other ways to develop their design project. Students are required to investigate “base case” as well as “alternative case” scenarios, which require that they “think outside the box”. The students use Chem Cad for simulation and other computer tools in this class
(5) an understanding of professional and ethical responsibility
- We discuss professional issues in class discussion using case studies.
- Students do literature reviews and must think outside the box to solve these real world relevant project problems. We discuss professional issues in class discussion using case studies.
- When interacting with the companies and organizations we discuss professional and ethical behavior. Many contemporary issues are discussed in class. Discussions of ethical responsibilities are a significant component of the capstone experience. This is done by consideration of the principle and case studies. Some of these case studies relate to topics: mobile truths, moral autonomy, duties and obligations, non-professional responsibilities. The current economic recession is discussed as part of the engineering economics section.
- Weekly homework assignments are required to be turned in on time and of high quality. Assignments are reviewed in class on a regular basis with either students or the instructor demonstrating competence.

(6) an ability to communicate effectively and the ability to function on multi-disciplinary teams.
- Students work in teams, with Honor’s Students entering the Governor’s Cup, an entrepreneurial competition. The students carry out the design project which they proposed in the Fall semester. These are team projects. Rotation of team leadership is encouraged so that many students have the opportunity to experience team leadership.
- Students present Powerpoint presentations at weekly meetings and several times during the semester. They present homework problems in class discussion. The groups visit their partner companies to present their design results at the end of the Spring Semester. Final deliverables include: Powerpoint, Poster and Report.

(7) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context, and knowledge of contemporary issues.
- All of the projects relate to contemporary issues such as separation and purification of antibodies and synthesis and characterization of single wall nanotubes. The global context of these projects relates to antibody products for biomolecular applications, extractive metallurgy leaching and biopolymers. Examples relate to global engineering and global context are discussed often in class. This may be related to engineering economics. Students will apply economics, safety, social and ethical considerations in design - , estimation of capital and manufacturing costs, discrete and cumulative cash flow diagrams, depreciation, taxation,
profitability analysis, discounted and non-discounted methods, incremental analysis, equipment alternatives and ethics case studies.

(8) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice, and a recognition of the need for, and an ability to engage in lifelong learning.

- Simulation software, ChemCad is used to provide modern engineering tools needed for process design.
- Students learn to do literature searches which allows them to practice lifelong learning activities.

Note: 1) The weekly assignment grade will include attendance at the weekly 12:00PM seminar series.
2) Registration fees for competitions are not included in the course fee and must be paid by the students.
**Anticipated Schedule**

There will be a five-hour lab session on Wednesdays, during which time there will be group presentations, group meetings and the bench scale models will be built and experiments will be carried out. The approximate schedule is given below, but the exact schedule will develop throughout the semester to best meet the needs of the students.

<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>1/21</td>
<td>Syllabus Overview and plan for semester. All Teams – PPT Due – 1/23</td>
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<tr>
<td>Week</td>
<td>Date</td>
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| 7    | 3/4   | Genentech Red – PPT  
      |       | Barrick Orange - PPT  
      |       | Genentech Green - PPT  
      |       | Barrack Blue - PPT  
      |       | TMWRF - Report  
      |       | Micromidas – Report  
      |       | Due – 3/6  |
| 8    | 3/11  | Genentech Red – Report  
      |       | Barrick Orange - Report  
      |       | Genentech Green - PPT  
      |       | Barrack Blue - PPT  
      |       | TMWRF - PPT  
      |       | Micromidas – PPT  
      |       | Due – 3/13  
      |       | Governors Cup Due – March 19  |
| 9    | 3/18  | Spring Break  |
| 10   | 3/25  | Genentech Red – PPT  
      |       | Barrick Orange - PPT  
      |       | Genentech Green - Report  
      |       | Barrack Blue - Report  
      |       | TMWRF - PPT  
      |       | Micromidas – PPT  
      |       | Due – 3/27  |
| 11   | 4/1   | Genentech Red – PPT  
      |       | Barrick Orange - PPT  
      |       | Genentech Green - PPT  
      |       | Barrack Blue - PPT  
      |       | TMWRF - Report  
      |       | Micromidas – Report  
      |       | Due – 4/3  |
| 12   | 4/8   | Genentech Red – Report  
      |       | Barrick Orange - Report  
      |       | Genentech Green - PPT  
      |       | Barrack Blue - PPT  
      |       | TMWRF - PPT  
      |       | Micromidas – PPT  
      |       | Due – 4/10  |
| 13   | 4/15  | Genentech Red – PPT  
      |       | Barrick Orange - PPT  
      |       | Genentech Green - Report  
      |       | Barrack Blue - Report  
<pre><code>  |       | TMWRF - PPT  |
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| 14 | 4/22 | Genentech Red – PPT  
|    |     | Barrick Orange - PPT  
|    |     | Genentech Green - PPT  
|    |     | Barrack Blue - PPT  
|    |     | TMWRF - Report  
|    |     | Micromidas – Report  
|    |     | Due – 4/24  |
| 15 | 4/29 | Submit semester project reports, posters and Powerpoint Presentations.  
|    |     | Due – 5/6  
|    |     | Equipment disassembly, waste disposal, lab cleanup.  
|    |     | **Hand in check out form signed by instructor by May 6.** |