

**EGEE 580 – Spring 2006**

**Design Engineering of Energy & Geo-Environmental Systems (5 Credits)**

**Location:** 201 WAGNER, T R 08:00A - 09:15 AM

Plus Additional Group Meetings To Be Arranged by Teams

**Faculty Facilitators:**

Chunshan Song; [csong@psu.edu](mailto:csong@psu.edu); 206 Hosler Bldg; 863-4466 [TR 4-5:30]

Derek Elsworth; [elsworth@psu.edu](mailto:elsworth@psu.edu); 231 Hosler Bldg; 865-2225

Jonathan Mathews, [jpm10@psu.edu](mailto:jpm10@psu.edu); 126 Hosler Bldg; 863-6213

Sarma Pisupati, [sxp17@psu.edu](mailto:sxp17@psu.edu); 126B Hosler Bldg; 865-0874

**Rationale:** This problem-based class will allow students to connect basic concepts and principles assimilated during prior classes to solve an industrial problem of societal significance. Students will work collaboratively as a team to finely prescribe the problem, to gather resources, and to synthesize a solution.

**Objective:** The principal objective of this problem-based course is to facilitate active and cooperative, or collaborative, learning to solve a contemporary problem in energy and/or the environment. This will be completed via literature search, critical literature review, identification of key issues (or concept mapping), work plan (or road mapping), written reports and oral presentations of results. The development of critical thinking and problem solving skills as a team in academic and industrial settings is the major focus of the course.

**Focus: CO<sub>2</sub> Capture, Sequestration and Utilization**

Greenhouse gas emission is a serious concern for global climate change, and carbon dioxide (CO<sub>2</sub>) is a major greenhouse gas from fossil energy utilization. Students will develop a framework to optimally capture, and sequester CO<sub>2</sub> to minimize CO<sub>2</sub> emission, and also utilize CO<sub>2</sub> for making useful chemicals and materials.

To define an appropriate scale, a 500 MWe electric power plant is selected as a prototypical stationary source of CO<sub>2</sub> emissions from fossil fuels, for which a wealth of data are available.

**Tasks:** Student participants will appreciate the global concerns of increasing atmospheric CO<sub>2</sub> concentrations, and the role of the recovery and utilization of fossil fuels in contributing to these concentrations in particular. In their development of a solution for optimal

capture/recovery/separation, sequestration, and utilization of CO<sub>2</sub>, optimality may be referenced to direct costs, to externalized and deferred costs, or to some other basis. A single common basis will be defined by the teams.

Participants will understand the chemistry and physics of fossil fuel utilization that leads to CO<sub>2</sub> emissions, their occurrence, stability and global abundance. They will identify, understand and evaluate the methods and the related chemistry, physics and processes of capturing and recovering CO<sub>2</sub> and the associated processes that affect the total amounts and the concentrations of CO<sub>2</sub> sources, and methods of sequestering CO<sub>2</sub>, and of utilizing CO<sub>2</sub>. They will identify the key societal and technical issues, identify and compare the current and potential future options, and evaluate their feasibility, and recommend the more environment-friendly and energy-efficient methods. Complete solutions must include a synthesis of methods to capture/recover, transport, sequester, and also utilize the CO<sub>2</sub>. A quantitative approach, including thermodynamic, kinetic and mechanistic analysis of proposed options must be considered, together with a preliminary economic analysis.

**Background:** An enormously large amount of CO<sub>2</sub> is emitted to the atmosphere every year causing a continuous and significant rise in atmospheric CO<sub>2</sub> concentration. Numerous studies have been, and continue to be, carried out on global carbon management related to climate change, CO<sub>2</sub> mitigation, CO<sub>2</sub> capture, CO<sub>2</sub> sequestration, CO<sub>2</sub> conversion and utilization. There are many publications and reports available. This is a real-world, open-ended problem to which there may be different approaches and different view points as well as controversial issues.

Literature review is an important part of this assignment in the initial stage, but a literature review (a written summary of literature) should be a critical survey and analysis, not a repetitive summary of what is already described in literature.

Critical thinking/analysis, creative (“out-of-the-box”) thinking/solution, and cooperative team work are expected from each team member.

**Involvement:** Students will collaborate in a team and take charge of the learning process as they attempt to solve the assigned problems. Importantly, they should identify and fully utilize the diverse knowledge present within the group – this will identify the key knowledge bases and learning needs required for the re-formulation and solution of a given problem. Students may use concept mapping to formulate the learning issues and map out the relationships between different concepts and principles to solve the assigned problems. Road mapping will be used to develop a strategy and a time line for problem solution. Students will make a critical review of the relevant literature to assess/reassess the proposed concept and road maps.

The results of the literature review and analytical work will be conveyed in written reports and oral presentations throughout the semester.

## Course Schedule and Assignments

[104 Hosler has been reserved for presentations and discussions during first three weeks (TR, 8-9:30 am during Jan 12-26); rooms for future meetings will be announced]

Date/Week	Topic
Week 1 (beg)	Introduction of the problem and discussion of course procedures and logistics for problem-based learning.
1 (end)	Presentation and discussion of individual and team concept maps (or any other format used for key issues) for defining the learning issues; student responses to assigned reading materials.
2 (beg)	Student presentation and discussion of learning issues for solving the problem, and individual and team re-statements (written) of the problem.
3 (end)	Student presentation and discussion of <b>individual</b> and <b>team work plan (or road maps)</b> for solving the problem
5	Presentation of a <b>critical literature review</b> and reassessment of the proposed <b>road map</b> for solving the problem; <b>finalize the team road maps</b> .
6	Presentation of progress
7	Presentation of progress
8	Submission of the <b>literature survey</b> and <b>submission and presentation of progress report and a comprehensive plan for future work</b>
9	Feedback from faculty facilitators
10	Revision and modification of <b>critical literature review</b> . Presentation of <b>critical-path plan</b> for recovery-through-utilization and identification of <b>final work-plan activities</b>
11	Presentation of progress
12	Presentation of progress
13	Presentation of progress
15	Presentation of progress and submission of final report
15	<b>Final Oral Examination</b>

## Team Assignments

Students will be grouped into 3 collaborative teams in this problem-based collaborative learning and problem-solving course:

CO<sub>2</sub> Capture and Recovery

CO<sub>2</sub> Transportation and Sequestration

CO<sub>2</sub> Conversion and Utilization

## Grading

Your course grade will depend on three components:

30%	Team work
50%	Individual presentations and final exam
20%	Peer evaluation
100%	

### The factors contributing to grades in these assigned distributions include:

- 1. Team work (30%).** This grade will be determined from an assessment of *critical and creative thinking, problem solving skills, and clarity and integrity* of reports and presentations.
  - a. 15% Concept Map (or identification of learning issues).
  - b. 15% Road Map.
  - c. 20% Literature Review.
  - d. 15% Progress Reports.
  - e. 10% Oral Presentation.
  - f. 25% Final Report.
- 2. Individual presentations and final exam (50%).** This grade will be determined from individual presentations and participations in discussions throughout the semester and a final oral exam on the whole problem at the end of the semester.

The following factors will be considered as equally important in assigning the grades for individual presentations (**20%**) and participations in discussions (**10%**).

- a. Active involvement in the learning and problem solving process
- b. Understanding of the problem and the related background issues,
- c. Critical and creative thinking,
- d. Problem solving skills and cooperation with other team members, and
- e. Clarity and integrity of presentations (progress and final).

For the final oral exam (**20%**), each student will give a 20-minute presentation of the final report and be questioned on the important learning issues for the whole problem.

- 3. Peer evaluation (20%).** This grade will be determined from confidential assessments (grades) from your team members. Each student will assign an individual **confidential grade** to each of her/his team members to evaluate their contribution to the learning issues, including **work load, leadership, resourcefulness, creativity, and peer teaching** effort. The criteria for the grade for peer evaluation will be discussed in the first class meeting. The overall peer evaluation grade for each student will be calculated as the mean of the assigned grades after discarding the top and bottom grades.

## **Academic Integrity**

Following University Policy 49-20, students are expected to maintain a high degree of academic integrity throughout all the course. Accordingly, activities such as cheating, plagiarism, facilitating dishonesty to others, etc., will not be tolerated. This course adopts the College's academic integrity policy. For more information, please check <http://www.ems.psu.edu/students/integrity/index.html>

## **Some Initiating Resources**

US Department of Energy. Carbon Sequestration Research and Development. A Report by DOE's Office of Fossil Energy and Office of Science, [http://www.fe.doe.gov/programs/sequestration/publications/1999\\_rdreport/index.html](http://www.fe.doe.gov/programs/sequestration/publications/1999_rdreport/index.html)

Web Resources About Problem-Based Learning:

University of Delaware PBL: <http://www.udel.edu/pbl/>

Concept Mapping Program: <http://cmap.ihmc.us/>