Jan 15, 2007

EGEE 580 – Spring 2007

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

Location: 22 Deike, T R 08:00A - 09:15 AM
Plus Additional Group Meetings To Be Arranged by Teams

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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.

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

Assignments: 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.

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

#1. Biomass energy utilization

Evaluate the paths and availability, growth potential and challenges of biomass and energy crops utilization and CO_2 mitigation.

#2. Bio-fuels production for transportation

Examine the types, paths, growth potential and problems of liquid fuels derived from bio-sources for use in transportation fuels.

#3. Geo-thermal energy recovery

Study the potential and challenges of geothermal energy recovery using CO_2 as a working fluid.

Problems: #1. Biomass energy utilization

Biomass, broadly defined, includes woody and algal biomass, crop residues, and energy crops. Biomass availability, growth, collection, transporation, and processing are all necessary for biomass energy utilization. Woody biomass contains different types of components for which the processing and utilization require different chemical or physical processes.

The student team would evaluate the paths and availability, growth potential and challenges of biomass and energy crops utilization and CO_2 mitigation.

#2. Bio-fuels production for transportation

Bio-fuels such as bio-ethanol and bio-diesel have become popular terms in renewable energy utilization research. Bio-ethanol is currently produced from corn, while cellulosic ethanol production is being studied. Bio-diesel is produced from chemical conversion of vegetable oils such as rapeseed oil. There are also liquid hydrocarbon fuels that can be made from bio-sources via chemical porocessing.

The student team would examine the types, paths, growth potential and problems of liquid fuels derived from bio-sources for use in transportation fuels. Evaluation of efficiency of the biofuel production and utilization should also be included in terms of net energy efficiency or life cycle efficiency.

#3. Geo-thermal energy recovery

Non-hydrothermal, or engineered, geothermal systems (EGS) offer the potential to deliver clean and sustainable energy close to the point of consumption. Despite this potential, and 30 years of experimentation, they have yet to produce a single kilowatt-hour of electrical energy in the US. Limiting issues relate to the expense of deep drilling, the uncertainties in creating a long-lived and low impedance reservoir, potentially unsustainable water losses, and the concomitant reluctance of oil companies to invest.

The limitation of water conservation is ameliorated if CO_2 is substituted as the heat transfer fluid, and economic constraints on drilling costs and uncertainties in creating a heat transfer circuit are removed if active petroleum reservoirs are utilized. The student team would investigate the feasibility of CO_2 injection in producing hydrocarbon reservoirs for combined, sequestration, EOR, and low-grade thermal energy recovery.

Background: An enormously large amount of fossil energy is being consumed on daily basis, which is depleting the amounts of readily available fossil resources and increasing the carbon-rich exhaust gases emitted to the atmosphere every year causing a continuous and significant rise in atmospheric CO_2 concentration. Renewable energy resources are attracting increasing attention worldwide because they do not deplet non-renewable energy sources and help to reduce greenhouse gas emission. In fact, numerous studies have been, and continue to be, carried out on the use of renewable energy resources for the sustainable energy development, and global carbon management related to climate change. 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.

Tasks: The central theme is renewable energy utilization for sustainable development. Student participants will appreciate the global concerns of rapidly depleting fossil energy resources, increasing atmospheric CO_2 concentrations, and the role of the recovery and utilization of renewable energy resources in contributing to the sustainable energy development.

To define an appropriate scale for a design case, a student team may use one or more states in the United States for quantitative evaluation of renewable energy (biomass, or geothermal energy), for which a wealth of data are available.

Participants will understand the basic issues of energy utilization, availability, growth potential along with basic chemistry and physics of renewable energy utilization that leads to meeting the increased energy demand while reducing the emissions of pollutants as well as CO_2 and other greenhouse gases.

They will identify, understand and evaluate the methods and the related chemistry, physics and processes of growing and recovering biomass energy, or producing and utilizing bio-fuels for transporation, or geothermal energy recovery using CO_2.

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 energyefficient methods. Complete solutions must include a synthesis of methods. A quantitative approach, including thermodynamic, kinetic and mechanistic analysis of proposed options must be considered, together with a preliminary economic analysis.

Grading

Your course grade will depend on three components:

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

The factors contributing to grades in these assigned distributions include:

1. **Team work (30%).** This grade will be determined from and assessment of *critical* and *creative thinking*, *problem solving skills*, and *clarity* and *integrity* of reports and presentations.
   a. 15% Identification of learning issues (or Concept Map).
   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.

The following 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.

Course Schedule and Assignments

[104 Hosler has been reserved for presentations and discussions during first three weeks (TR, 8-9:15 am during Jan 15-26); 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; Teaming assignments.
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 **individual** and **team work plan (or road maps)** for solving the problem
5	Presentation of a **critical literature review** and reassessment of the proposed **road map** for solving the problem; **finalize the team road maps**.
6	Presentation of progress
7	Presentation of progress
8	Submission of the **literature survey** and **submission and presentation** of **progress report and a comprehensive plan for future work**
9	Feedback from faculty facilitators
10	Revision and modification of **critical literature review**. Presentation of **critical-path plan** for recovery-through-utilization and identification of **final work-plan activities**
11	Presentation of progress
12	Presentation of progress
13	Presentation of progress
15	Presentation of progress and submission of final report
15	**Final Oral Examination**

Some Initiating Resources

US Department of Energy. National Renewable Energy Laboratory. NREL Biomass Program has a comprehensive webiste on biomass and biofuels. http://www.nrel.gov/biomass/

US DOE's vision for Hydrogen Energy, FutureGen, and Advanced Nuclear Energy proposals all rely upon safe sequestration of energy byproducts, including CO_2. Details of these needs are included in "Basic Research Needs for Advanced Nuclear Energy Systems", "Basic Research Needs for the Hydrogen Economy", and "Basic Research Needs to Assure a Secure Energy Future" all commissioned by DOE Office of Basic Energy Sciences and available at http://www.er.doe.gov/bes/reports/list.html.

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

Web Resources About Problem-Based Learning:

National Teaching and learning Forum: http://www.ntlf.com/html/pi/9812/v8n1smpl.pdf

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

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

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

PEER EVALUATION FORM

Please rate yourself and your team members on the relative contributions that were made in solving the problem and preparing and submitting your group reports. *Your ratings will not be disclosed to other students.* Be honest in this evaluation!

In rating yourself and your peers, use a one to five point scale, where **5 = Superior; 4 = Above Average; 3 = Average; 2 = below average; and 1 = weak.**

Insert **your name** in the first column and your peers' names in the remaining spaces. (One name at the top of each column).

Names							
Participated in group meetings or discussions							
Helped keep the group focused on the task							
Contributed useful ideas							
Quantity of work done							
Quality of work done							
Enter total scores here							