# Climate Change Mitigation

Civil & Environmental Engineering 107
Spring Semester 2015
CCN 14111; 3 units


## Instructor

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## Teaching Assistant (GSI)

Olga Kavvada (okavvada@berkeley.edu)
OH: M 4:30-6; Tu 10:30-12:00; W 10:00-11:00
OH location: 651 Davis Hall


## Course Meetings

Lectures: MWF 11-12 PM in 502 Davis Hall
Optional discussion periods: M 12-1 in 534 Davis Hall; M 1-2 in 534 Davis

## Course Description

One of the world's biggest environmental challenges is climate change. This threat is mainly caused by an accumulation of greenhouse gases resulting from large-scale anthropogenic processes. Carbon dioxide ($CO_2$) release from fossil-fuel use is a dominant factor. Engineers can play important roles in responding to this threat by the development and application of appropriate technologies. This course begins by establishing the scientific basis for concern about climate change, emphasizing the scale of change required to move from business as usual to a sustainable trajectory. Fossil-fuel-based energy systems are the dominant contributors to greenhouse gas accumulation, and so the course considers current and future energy systems, emphasizing electricity and transportation and considering both supply and end-use. Important alternatives are explored, such wind turbines, solar photovoltaic devices, and biofuels. Important technologies that can reduce end-use energy demand are assessed, such as those applied in buildings (lighting and cooking appliances) and in transportation (electric and fuel-cell powered vehicles). In addition to altering energy systems, other mitigation technologies are considered, such as those that aim to sequester greenhouse gases or to directly influence the electromagnetic radiation balance of the earth. An example is the capture of $CO_2$ from large-scale fossil-fueled units with subsequent disposal by deep saline injection.

## Student Preparation (see also handout posted on bCourses)

This class is designed for upper division and graduate students with backgrounds in engineering or physical sciences. Solid preparation for this course is one year of college-level physics (such as Phys 7AB), one year of college chemistry (Chem 1AB), and math through a first course in differential equations (Math 54). Although not required, some prior upper-division experience in environmental engineering, environmental science, or energy technology would be useful, e.g. CE 111, ER 102, ER 100.

## Course Structure

- Three hours of lecture per week (required), plus one hour per week of discussion (optional).
- Ten problem assignments that aim to develop skill in engineering analysis and domain knowledge on climate-change mitigation.
- Two in-class midterm exams plus a final exam.

## Posted Course Materials

All materials are posted on bCourses in the course folder "CE 107 Sp15 Resources"

- Discussion Materials — the GSI will use this folder to post any materials associated with the discussion periods that she leads.
- Exam Solutions — after the midterm and final exams, solutions will be posted here.
- Handouts — Materials distributed during class will be posted here. Some additional materials may be posted that are not printed and distributed. The postings are numbered to facilitate keeping track of what is new.
- Lecture Notes PDF — Narrative summaries of lecture material, originally written in 2003 and updated in 2005.
- Lecture Visuals — Powerpoint slides that illustrate lectures, originally prepared in 2008 and most recently updated in 2014. (Further updates may be posted during the semester.)
- Problem Assignments — Ten assignments will be posted here, typically 1 week before the due date. Printed copies of the assignments will be distributed in lecture.
- Problem Solutions — Solutions to the assignments are posted shortly after the due date.
- Readings (assigned) — Students are assigned to read ten articles selected from the technical literature. Each reading addresses an important aspect of course material.
- Readings (notes) — Brief synopses of each of the assigned readings.
- Sample Exams — Samples midterm and final exams, with solutions.

## Assignment Due Dates

Jan 28, Feb 4, Feb 11, Feb 25, Mar 11, Mar 18, Apr 1, Apr 15, Apr 22, Apr 29

## Exam Dates

• Midterm #1: Wednesday 4 March
• Midterm #2: Wednesday 8 April
• Final exam: Tuesday, 12 May 7-10 PM

## Exam Policies

All exams are conducted under the same ground-rules. The exams are closed-book, closed-note, except that students may bring to the exam room a small number of pages of notes. You'll be expected to bring and use a calculator. Laptops and other computers are not allowed. No devices are permitted that allow wireless communication, such as smart phones. To receive full credit, you must show work leading up to the answer, not just the answer itself. For students with DSP accommodations, please contact Professor Nazaroff at least two weeks ahead of each exam to initiate the arrangements.

## Teaching Philosophy and Ethics

My teaching is guided by the following beliefs. I do my best to apply these ideas in the design and operation of all courses I teach, including CE 107.

(a) The highest achievements in engineering build upon a solid understanding of scientific fundamentals, combined with commitment to apply such understanding for the betterment of society.
(b) Learning is a lifelong pursuit; the best teachers are enthusiastic learners.
(c) Students share responsibility for their education. Teachers play an important role in empowering students to recognize and act on this responsibility.

(d) The standards of performance at UC Berkeley are and should be high. Faculty members should establish and maintain high standards and encourage students to do their best.
(e) Students have a diverse range of academic abilities and learning styles. Teachers should motivate and facilitate learning by students at all ability levels. Every student should feel challenged to do her best, and each student's achievements should be appropriately recognized and rewarded.
(f) Course activities should be structured to provide a high ratio of learning potential per unit student effort.
(g) I follow the UC Berkeley "principles of community" and the "honor code." I expect students who participate in my classes to do the same. See http://www.asuc.org/honorcode/index.php and http://www.berkeley.edu/about/principles.shtml.

## Classroom Courtesy

We have a limited amount of time together (lecture time = 38 × 50 min = 32 h) and a lot of important material to cover. Class will start and end very close to the scheduled times. Please make a concerted effort to be in class and ready to listen by 11:10. Also, I use visual feedback from students to pace my lectures. It is distracting and degrades lecture quality when your attention is focused on something other than course material. Using electronic devices to support your learning are welcome. However, please don't use e-toys for other purposes during lecture.

## Problem Assignments: Policies and Procedures

1. Assignments generally are distributed in class on W and will be due at 4 PM the following W. Assignments may be submitted in class on W, or to the locked CE 107 drop-box in O'Brien Hall, immediately outside Room 212.
2. **Late work is not accepted.**
3. Regarding collaboration: The work you submit is to be your own. If, after making an attempt at solving a problem, you are stuck, you may consult with the instructor or GSIs. You may also talk over the problem with other students in the class. But you **may not** examine the written work of any other student or solutions from previous semesters. This rule reflects the situation you will most likely face in professional practice: there will be experts with whom you can consult on tough problems, but ultimately, you will be expected to make independent contributions to their solution.
4. The problem sets in this class are to give you practice in (a) solving engineering problems, and (b) communicating results. The following approach is recommended:
   - Restate the objective — many errors arise from not understanding what a problem asks.
   - Identify the physical setting of the problem
     - If appropriate, draw a system figure, label the dimensions, axes, and list other important parameters. If a sketch is not appropriate, give a brief statement of the physical setting.
     - Differentiate among the information that is given by the problem statement, information that you obtain from other sources, and your assumptions.
   - Solve the problem, showing all assumptions, without skipping steps, and including a brief running commentary. Circle all answers and call attention to important intermediate results. Use precision appropriately in expressing your answers (see handout).
   - Discuss briefly the significance of the results.

   You are responsible for the clarity of your work. If the grader cannot follow what you have done, then you may not receive full credit even if the work is correct.

5. To minimize the risk of reader burnout, please (a) express your answer in the units requested, and (b) box, circle, or otherwise clearly identify your answer. **Neatness counts** (not only in school but also in the real world)! The reader is authorized to deduct points for work that is sloppy or otherwise difficult to follow.
6. Each problem will be scored on a 4-point scale, as follows:
   4 points — problem done accurately and work presented clearly
   3 points — conceptually okay; minor error(s) in analysis and/or work difficult to follow
   2 points — major errors in approach or analysis
   < 2 points — substantially incomplete; not a serious effort
7. Solutions to the problem assignments will be posted on bCourses. It is valuable to study the solutions even if you earn high scores.

## Grading

Grades will be based on 10 problem sets, two in-class midterm examinations, and a comprehensive final examination. Final grade weighting: PS — 25%; MT exams — 30%; Final exam — 45%. Each student's PS score will be based on the 9 highest PS scores during the semester; the lowest score will be discarded.

Grades are not negotiable! The grade assigned in this course reflects my subjective assessment of each student's performance. The grade is based on objective data from problem assignments and examinations. "Excellent" performance is necessary to earn an "A". Typically, this will require that all assignments are submitted on time and show high quality work. The exams must demonstrate thorough mastery of the concepts presented in this course and an ability to apply the concepts insightfully and accurately in engineering analysis.

I've taught CE 107 nine times since introducing it in the Sp 2003 semester. Below is a summary of grade results from the four most recent offerings as well as an overall summary. Among 158 undergraduates during these four offerings, 29% earned A's, 49% earned B's, and 18% earned C's. Among 59 graduate students, 42% earned A's and the rest earned B's. This information is only indicative of my expectations for grading this semester.

| | Sp 2011 | Sp 2012 | F 2012 | Sp 2014 | TOTAL |
|---|---|---|---|---|---|
| No. students (No. UGs) | 56 (46) | 48 (35) | 27 (14) | 91 (63) | 222 (158) |
| No. earning A's (UG A's) | 16 (11) | 20 (11) | 9 (5) | 26 (19) | 71 (46) |
| Assignment score, average | 94% | 95% | 96% | 96% | 95% |
| Midterm score, average | 86% | 96% | 92% | 90% | 91% |
| Final exam score, average | 87% | 86% | 88% | 88% | 87% |
| No. earning B's (UG B's) | 27 (22) | 20 (16) | 16 (7) | 49 (33) | 112 (78) |
| Assignment score, average | 91% | 90% | 96% | 92% | 92% |
| Midterm score, average | 69% | 82% | 74% | 79% | 76% |
| Final exam score, average | 75% | 75% | 73% | 74% | 74% |
| No. earning C's (UG C's) | 12 (12) | 6 (6) | 2 (2) | 9 (9) | 29 (29) |
| Assignment score, average | 75% | 75% | 83% | 82% | 78% |
| Midterm score, average | 47% | 53% | 47% | 62% | 53% |
| Final exam score, average | 57% | 58% | 43% | 55% | 56% |