CVEN 5834: Sustainable Engineering Design
Fall 2017

Instructor	Sherri Cook S299 SEEC (http://www.colorado.edu/even/about-us/map-and-directions/access-seec-environmental-engineering-computer-lab) Email: sherri.cook@colorado.edu Office Hours*: Tuesdays and Fridays 1-2pm (starting Sept 5) *Any changes will be announced in class
Course Time and Location	Tuesdays & Thursdays, 10:30-11:45am; SEEC N126
Course Homepage	D2L: https://learn.colorado.edu/
Course Prerequisites	Graduate standing or permission of the instructor. There are no specific prerequisites, but this course requires engineering problem solving skills and a basic working knowledge of material and energy balances.
Text *(not required)*	There is no required text. Readings will consist of peer-reviewed journal articles and reports, supplemented with online videos (posted on D2L).
Computers & Software *(Bechtel access required)*	Students will need to bring laptops to the majority of lectures, both for in-class examples and for design team working sessions. Students will have access to relevant software (e.g., SimaPro, @Risk, MATLAB, etc.) through the Bechtel labs (ECCE 157). Students need to sign up for access to the Bechtel Lab at the 4th floor CEAE main office.
Course Description	Students will develop an understanding of quantitative sustainable design and how to navigate engineering decision-making. Students will learn tools for economic (life cycle costing, LCC) and environmental (life cycle assessment, LCA) sustainability assessments, and how to link these tools to engineering design decisions under uncertainty. Students will design engineered technologies individually and in teams, with special attention to energy and water technologies. Main course objectives are that students will have the ability to assess the relative sustainability of design alternatives using quantitative tools and to complete the detailed design of civil/environmental engineering infrastructure while navigating trade-offs across and within dimensions of sustainability. *3.0 Credit Hours.*
Course Objectives	At the completion of the course, students should be able to: 1. Explain the fundamental principles of sustainability science and sustainable design. 2. Describe the main sustainability challenges facing society. 3. Apply sustainable design to engineering designs and problems. 4. Understand and describe the interconnectedness of energy systems, water systems, and the environment across temporal and spatial scales. 5. Assess the environmental impacts of engineered infrastructure using life cycle assessment (LCA) methodology. 6. Assess the economic sustainability of engineered infrastructure using life cycle costing (LCC) methodology. 7. Compare and contrast the environmental, social, and economic sustainability of specific engineering designs. 8. Plan a sustainability evaluation of an engineered technology. 9. Design civil/environmental infrastructure under uncertainty to meet specific objectives within environmental, social, and economic constraints. 10. Work in teams to identify the need for a process, propose evaluation criteria, formulate design alternatives, and recommend the most sustainable alternative in oral and written form.

Grading	Class Participation and Conduct	10%
	Homework	25%
	Other Assignments (in-class examples, quizzes)	15%
	Design Project [a]	45%
	[a] Your final grade for the design project will be adjusted based on peer evaluations from your design team.	
Class Participation and Conduct	Class sessions will regularly include activities during which students will work with partners to improve their understanding of course material. Partners may periodically be asked to submit effort and professionalism assessments of their peers (i.e., peer ratings) for in-class activities. These assessments, coupled with design team peer evaluations, instructor observations, and attendance, will be incorporated into the Class Participation and Conduct grades.	
Homework	Homework assignments will be due at the start of the class period. Late homeworks will be accepted, with 50% penalty, until 48 hours after due date; after that time, no late homeworks will be accepted. It is essential that each student complete homework assignments in order to fully grasp course concepts that will be tested on exams. Students are allowed (*and encouraged*) to discuss problem solving strategies with their classmates; however, each student must hand in solutions that have been generated individually. *Violations of the honor code will be strictly enforced.* To receive full credit, all steps to solving problems need to be presented in a clear and logical manner. All problem assumptions, known parameters, and governing equations should be clearly listed, and all assumptions should be adequately tested when feasible. A person who is technically literate should be able to read your problem solutions and easily follow the logic that you used to arrive at your final solution. Points will be deducted for sloppy presentations.	
Design Project	This course includes an integrated final design project. The design project will be completed in self-assembled teams on a team chosen topic (with instructor approval). It will include a final report and oral presentation at the end of the semester, as well as deliverables (e.g., design details, LCA methodology write-up, update presentation, etc.) throughout the semester. Additional details will be provided at the start of the semester.	
Re-Grading	Grades will not be discussed on the day the assignment is returned to the student. Re-grade requests must be submitted in writing and will be accepted for consideration up to one week after the assignment or exam has been returned. Students should be aware that the entire assignment will be re-graded by the instructor, not just the portion in question.	

Approximate Course Schedule[1]:

DATE	TOPIC	ASSIGNMENTS (due before start of class)
Aug 29	Course Introduction & State of the World ***[Module 1]***	
Aug 31	Energy & Water Systems – Grand Challenges ***[Module 1]***	Reading #1 – Conklin 2006 TED #1 – Hans Rosling
Sept 5	How to Give Effective Presentations ***[Module 0]*** Design Process Overview – Structuring Design Problems as a System of Equations ***[Module 2]***	TED Talk #2 – Amory Lovins Reading #2 – Zimmerman et al. 2008
Sept 7	Individual Presentations on Project Ideas Design Process Overview – Structuring Design Problems as a System of Equations Continued ***[Module 2]***	**Project Deliverable #0 –Idea Presentations**
Sept 12	Design Process Overview – Linking Design Decisions to Sustainability Metrics ***[Module 2]***	Reading #3 – Guest et al., 2009
Sept 14	Design Process Overview – Succinic Acid Production Process Design & In Class Exercise ***[Module 2]***	**Project Deliverable #1—Project Proposal** Reading #4 – Succinic Acid Review
Sept 19	Design Process Overview – Traditional Design and Sustainable Design in Practice ***[Module 2]***	Reading #5 – CRD Project Design Report
Sept 21*	**Working Session 1** – Teams meet and get direct feedback from Instructor (2017 - group meetings on Sept 18 instead of Sept 21)	**Homework #1—Mass & Flow Balance**
Sept 26*	Economic Sustainability Assessment – Introduction to Economic Concepts (nutrient trading or EPA energy exercise) ***[Module 3]***	Readings in D2L folder
Sept 28	Design Team Presentations on Project Proposals	**Project Deliverable #2—Update Presentation**
Oct 3	Economic Sustainability Assessment – Life Cycle Costing (LCC) and TEA Overview & Introduction ***[Module 3]***	Reading #6 – Rebitzer & Hunkeler, 2003 Reading #7 – Korpi and Ala-Risku, 2008
Oct 5	Economic Sustainability Assessment – Comparative and Incremental Assessments ***[Module 3]***	**Project Deliverable #3—Design Basis**
Oct 10	Economic Sustainability Assessment – Finance Concepts and Environmental Valuation ***[Module 3]***	Reading #8 – Rebitzer et al., 2003
Oct 12	**Working Session 2/3** – Teams Work on Projects In-Class with Direct Feedback from Instructor	**Homework #2 - TEA**
Oct 17	Environmental Sustainability Assessment – Life Cycle Assessment Overview & Introduction ***[Module 4]***	TED Talk #3 – Rockstrom Reading #9 – EPA LCA Report, Part 1 **Project Deliverable #4 – LCC Methodology**
Oct 19	Environmental Sustainability Assessment – Life Cycle Assessment Mechanics ***[Module 4]***	Reading #10 – EPA LCA Report, Part 2
Oct 24	Environmental Sustainability Assessment – SimaPro Introduction – Computer Lab In-class Exercise ***[Module 4] – Bechtel Lab East Side***	Reading #11 – Bare et al., 2000
Oct 26	Environmental Sustainability Assessment – Comparative Life Cycle Assessment In-class Exercise ***[Module 4] – Bechtel Lab East Side***	Reading #12 – Hendrickson et al. 1998
Oct 31	**Working Session 4** – Teams Work on Projects In-Class with direct feedback from Instructor	**Homework #3 – LCA**
Nov 2	Understanding Performance – Sensitivity & Uncertainty Analyses ***[Module 5]***	**Project Deliverable #5 – LCA Methodology**
Nov 7	Understanding Performance – Uncertainty & Sensitivity Analyses Software In-class Exercise ***[Module 5] – Bechtel Lab East Side***	
Nov 9	**Working Session 5 – *Bechtel Lab East Side***	
Nov 14*	Understanding Performance – Results Presentation & Interpretation ***[Module 5]***	**Project Deliverable #6 – Sensitivity & Uncertainty Methodology**
Nov 16	**Working Session 6** – Teams meet and get direct feedback from Instructor (2017 - group meetings on Nov 17 instead of Nov 14)	**Homework #4– Sensitivity & Uncertainty**
Nov 22	**Fall Break**	
Nov 24	**Fall Break**	
Nov 28	Understanding Performance – Uncertainty & Sensitivity Data Analysis In-class Exercise ***[Module 5]***	
Nov 30	**Working Session 7a** – *Checking Your Model & Preliminary Results* – Teams Work on Projects In-Class with direct feedback from Instructor	**Project Deliverable #7 – Preliminary Results**
Dec 5	**Working Session 7b** – *Data Analysis and Results Presentation* – Teams Work on Projects In-Class with direct feedback from Instructor	**Homework #5– Navigate Tradeoffs**
Dec 7	**Working Session 8 – *Bechtel Lab East Side***	
Dec 12	**Final Presentations** OR **Lecture** on The Future of Sustainable Design ***[Module 6]***	Reading #13 – Daigger 2009 Reading #14 – King et al. 2008 Reading #15 – Guinee et al., 2011
Dec 14	**Final Presentations**	**Final Presentations**
Dec 17	Final reports due by end of exam time (no in-class exam)	**Final Reports**

[1]Schedule subject to change (announcements will be made in class)

University Policies

All of CU's Policy statements are important to this class. Please become familiar with the CU policies at http://www.colorado.edu/policies/ and take particular note of those policies listed below. Please do not hesitate to ask me for clarification about how any of these policies relate to our class.

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website (www.colorado.edu/disabilityservices/students). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or injury, see Temporary Medical Conditions under the Students tab on the Disability Services website and discuss your needs with your professor. This course requires the use of the SimaPro LCA software, which either is not currently accessible to individuals using assistive technology or may not yet have been reviewed fully for accessibility. If you use assistive technology to access the course material, please contact your faculty member and Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu as soon as possible to discuss other effective means for providing equal alternate access.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, the instructor should be notified within the first two weeks of the course of any potential conflicts, and I will be happy to make reasonable and appropriate accommodations. See full details at http://www.colorado.edu/policies/fac_relig.html. See the campus policy regarding religious observances for full details.

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior and the student code.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to maintaining a positive learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, discrimination, harassment or related retaliation against or by any employee or student. CU's Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking or related retaliation. CU Boulder's Discrimination and Harassment Policy prohibits discrimination, harassment or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment or related retaliation can be found at the OIEC website.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the academic integrity policy. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at the Honor Code Office website.