The University of Texas at El Paso
Sustainability Engineering and Life Cycle Assessment – IE 4395
Fall 2022 – Course Syllabus

Professor: Dr. Ana C. Cram

Office: Engineering Building Room A-241

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Class meets: Education Building, 301, Mondays and Wednesdays 11:00 am – 12:20 pm

Office hours: Mondays and Wednesdays 1:00 pm to 2:00 pm or by appointment

Course web page:
https://blackboard.utep.edu/

Course Description:
This course in sustainability engineering and energy systems is interdisciplinary and covers the design, manufacturing, supply, and systems aspects of sustainability engineering. The class will present the case for global sustainability, energy management, design for the environment, carbon footprint analysis, and Life Cycle Assessment (LCA). LCA is a rigorous, quantitative approach to environmental impact evaluation that tallies products' impacts throughout their lifetimes. It has been used successfully in several industries (particularly packaging and manufacturing). Moreover, this course will provide an understanding of conventional and sustainable energy production and utilization that will serve as a foundation for Renewable Energy Systems and Natural Resources. In this course, different alternative energy sources available, including renewable energy (hydroelectric, solar, wind, biomass, and geothermal), will be reviewed. Each energy source's pros and cons, based on our needs, availability, and environmental impact aspects, will be discussed.

Prerequisites:
BE 3373: Engineering Probability and Statistical Models (with a grade of "C" or better)

Course objectives:
- To provide a holistic systems approach to assess the environmental impacts of different systems
- To evaluate life cycle analyses of products and/or processes and propose strategies for addressing environmental impact while still meeting design and economic requirements.
- To propose design changes to a product to enhance recycling, reuse, and/or remanufacturing capability with consideration of the economics of these activities.
- To learn about the energy situation and relevant economic and environmental issues;
- To understand the technical nature of energy and apply fundamental design concepts for efficient and renewable systems at both a community and site scale

Required textbook:
There is no required textbook; reading materials will be assigned during the semester

Useful references:

1. Curran M. A. (1996). Life Cycle Assessment: Principles and Practice. Scientific Applications International Corporation (SAIC). Environmental Protection Agency. Systems Analysis Branch. National Risk Management Research Laboratory. FREE- Link: http://www.epa.gov/nrmrl/std/lca/lca.html
2. Klöpffer, W., and Grahl B. (2014). Life Cycle Assessment (LCA). Ed. Wiley.
3. Jonker G and Hamsen J, (2012). Engineering for Sustainability: A Practical Guide for Sustainable Design. 1st Edition. Elsevier
4. Hendrickson C. T. (2006). Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach. Ed. Routledge
5. Vanek, F., Albright L., and Angenent (2016). Energy Systems Engineering: Evaluation and Implementation. 3rd Ed. McGraw-Hill
6. Wengenmayr, R., and Bührke, T. (2008). Renewable Energy: Sustainable Energy Concepts for the Future. Ed. Wiley.
7. Tester J. W., Drake E. M., Driscoll M. J., Golay M. W., and Peters W. A. (2005). Sustainable Energy: Choosing Among Options. Ed. The MIT Press
8. Da Rosa A. D. (2009). Fundamentals of Renewable Energy Processes. Ed. Academic Press
9. Ristinen R. A. and Kraushaar J. P. (2005). Energy and the Environment. Ed. Wiley

Grading

ITEM	**Percentage**
Journal(s) critique and presentations	15%
GHG Protocol presentation	5%
Labs and Homework assignments	15%
Final project report	20%
Final Project presentation	15%
Exam 1	30%

- **There will be no makeup exam administered**. If you have a **university-approved excuse**, your instructor will have a process for determining how to handle the missing grade outlined in the syllabus. However, no makeup exams will be given.
- No late Homework will be accepted. No excuses!!
- Excuses for positive Covid-19 cases will be accepted if proper positive results are provided. Such results should include your full name. No at-home Covid-19 tests will be accepted. UTEP offers free Covid-19 testing on campus for students attending face-to-face and/or remote classes. For more information on the testing locations, please visit: https://www.utep.edu/ehs/covid/

Student participation

The course is designed to be an enjoyable learning experience for everyone, with support for every participant. This course will immerse students into a community of practice so that students can develop skills and knowledge that facilitate their professional development. Students are expected to complete all weekly content and to participate actively and respectfully on discussion boards, chats, and blogs. Furthermore, students should finish quizzes and deliver complete quality assignments and projects on time.

The following policies will be enforced:

1. Students must complete all discussion boards assigned to receive a grade.
2. Students who miss more than 40 % of the final grade will be dropped from the course.
3. Students who have many absences and little or no activity in the course will be dropped.

Course Rule policies for blackboard discussions

- **Remember your place**: A Web-based classroom is still a classroom, and comments that would be inappropriate in a regular classroom are likely to be inappropriate in a Web-based course as well.
- **This is permanent**: Think carefully about the content of your message before contributing it. Once sent to the group, there is no taking it back. Members of the class and the instructor will be reading any postings.
- **Respect your fellow students and instructor.** Respect and courtesy must be provided to classmates and to instructor at all times. Do not use inappropriate language, all capital letters, or language short cuts. No harassment, flaming, or inappropriate postings will be tolerated.
- **Giving feedback professionally**: Write constructive feedback by addressing the idea, not the person. People may have different points, positions and believes in the aspects being discussed. The discussion must be limited to the aspects/ideas only. Personal attacks are not tolerated. When reacting to someone else's message, address the ideas, not the person. Post only what anyone would comfortably state in a face-to-face situation.
- **Be forgiving:** If someone states something that you find offensive, mention this directly to the instructor. Remember that the person contributing to the discussion is also new to this form of communication. What you find offensive may quite possibly have been unintended and can best be cleared up by the instructor.
- **Language**: Given the absence of face-to-face clues, written text can easily be misinterpreted. Avoid the use of strong or offensive language and the excessive use of exclamation points. If you feel particularly strongly about a point, it may be best to write it first as a draft and then to review it, before posting it, in order to remove any strong language.
- **Test for clarity**: Messages may often appear perfectly clear to you as you compose them, but turn out to be perfectly obtuse to your reader. One way to test for clarity is to read your message aloud to see if it flows smoothly. If you can read it to another person before posting it, even better.
- **Submit quality work.** Online entries should be written in Standard Writing English with edited spelling, grammar, and punctuation. Although the grammar and spelling of a

message typically are not graded, they do reflect on you, and your audience might not be able to decode misspelled words or poorly constructed sentences. It is a good practice to compose and check your comments in a word-processor before posting them.

- **Follow the parameters / Stick to the point:** Follow the posting requirements and parameters set up by your professor. Contributions to a discussion should have a clear subject header, and you need to stick to the subject. Don't waste others' time by going off on irrelevant tangents.
- **Read first, write later:** Don't add your comments to a discussion before reading the comments of other students unless the assignment specifically asks you to. Ignoring your fellow students is rude. Avoid repetition of what someone else has already said. Add something new to the discussion. Comments related to the content of previous messages should be posted under them to keep related topics organized, and you should specify the person and the particular point you are following up on.
- **Quality posts get credit:** There is no credit for yes/no answers. Posts should justify positions and provide specific examples. Students must demonstrate that they have read the assignment and their classmates' comments carefully and thoughtfully.
- **Meet the deadline:** Be sure to post in a timely fashion to receive credit for attendance and for the discussion.

Software use:

A) GaBi®

GaBi stands for "Ganzheitliche Bilanz," which in German means Holistic Balance. GaBi® is considered one of the leading worldwide tools for Life Cycle Assessment. GaBi® is a user-friendly, powerful, and professional tool supporting users in sustainable life cycle data modeling, administration, and evaluation on the process, product, or organization level. GaBi serves for efficient completion of tasks such as

- Life Cycle Assessment (LCA) according to ISO 14040/44
- Life Cycle Engineering (LCE)
- Product and Process Optimization
- Design for Environment (DfE)
- Environmental Product Declarations (EPD)
- Sustainability Assessment – environmental/economic/social
- Life Cycle Costing (LCC)
- Energy and Resource Efficiency Analyses
- Greenhouse Gas Accounting
- Sustainability Benchmarking

B) HOMER®

HOMER is the global standard for optimizing microgrid design in all sectors, from village power and island utilities to grid-connected campuses and military bases. Originally developed at the National Renewable Energy Laboratory (NREL), and enhanced and distributed by HOMER Energy, HOMER (Hybrid Optimization Model for Multiple Energy Resources). It is a computer model that simplifies the task of evaluating design options for both off-grid and grid-connected power systems for remote, stand-alone, and distributed generation (DG) applications. HOMER models both conventional and renewable energy technologies

C) SimaPro

SimaPro is an LCA professional software tool to collect, analyze, and monitor the sustainability performance of products and services. It measures environmental impacts across all cycle stages and identifies the hotspots in all aspects of supply chain, from raw materials extraction to manufacturing, distribution, use, and disposal. SimaPro comes fully integrated with various databases and impact assessments and is used for a variety of applications: (1) Carbon footprint; (2) Water footprint; (3) Product design and eco-design (DfE); (4) Environmental Products Declarations (EPD); and (5) Determination of key performance indicators (KPIs).

D) GREET

The Greenhouse gas Regulated Emissions and Energy Use in Transportation (GREET) model is a tool that simulates the energy use and emissions output of various vehicle and fuel combinations—sponsored by the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy. GREET offers two free platforms to use: the GREET.net model and the GREET Excel model.

E) SWAT

The Soil & Water Assessment Tool (SWAT) is a small watershed to river basin-scale model used to simulate the quality and quantity of surface and groundwater and predict the environmental impact of land use, land management practices, and climate change. SWAT is widely used in assessing soil erosion prevention and control, non-point source pollution control, and regional management in watersheds. The SWAT model was developed by the United States Department of Agriculture (USDA), Agricultural Research Services (ARS).

F) STELLA

STELLA (Systems Thinking, Experimental Learning Laboratory with Animation); is a visual programming language for System Dynamics Modeling (SDM) introduced by Barry Richmond in 1985. The program is distributed by isee systems. STELLA is a flexible computer modeling package with a smooth, intuitive interface that allows users to construct dynamic models that realistically simulate complex systems (Agriculture, Energy, Transportation, etc.). Given the combination of ease of use and modeling power, the STELLA system is ideal for interfacing with research experiences. In its most basic form, modeling in STELLA proceeds in three steps: 1) constructing a qualitative model, 2) parameterizing it, and 3) exploring the model's dynamics.

G) EdGCM

In this course, you will learn about general climate change models (GCMs) and how climatologists use them to test hypotheses about the mechanisms governing past and potential future climates. We will use a model called EdGCM (Educational Global Climate Modeling), specially designed for educational applications. EdGCM is based on a NASA climate model called GISS (for the Goddard Institute of Space Science). NASA- GISS was developed in the 1980s and became famous because it provided some of the earliest quantitative estimates of 20th-and 21st-century global warming. EdGCM's 'guts' are identical to this version of NASA-GISS, but extensive visualization and analysis tools have been added. Personal computers are powerful enough now that runs that once required weeks of supercomputer time can now be completed in a day on a desktop PC or Mac. Through homework exercises, you will learn how to use EdGCM and how to design climate model experiments. Then, working in teams of 3 students, you will design your

experiment, run EdGCM, prepare visualizations of critical results, and present your work to the rest of the class.

Project Description

The main objective of this project is for the students to have the possibility to apply and explore additional topics related to sustainability. For instance, the project may be based on a literature review related to a specific renewable energy system and/or the presentation of alternative software to perform LCA or analysis related to renewable energy systems to the class, for example:

- Present different designs of a particular product and evaluate its environmental impacts
- Environmental impacts of two existing similar products
- Perform a cradle-to-gate analysis of a wind turbine, solar panel, etcetera.
- Focus on a specific renewable energy source and present how the widespread implementation of the technology will help minimize the impact on the environment when compared with traditional "fossil fuel" technologies.
- The presentation of different material as a lab exercise of a different software tool to the class to perform LCA or energy systems analysis (software used must be free for the students to download), e.g., BEES, UMBERTO, etc

Academic Honesty

Academic dishonesty is prohibited and is considered a violation of the *UTEP Handbook of Operating Procedures*. It includes but is not limited to cheating, plagiarism, collusion, and fabrication.

1. Cheating can involve copying from or providing information to another student, possessing unauthorized materials during a test, or falsifying research data on laboratory reports.
2. Plagiarism occurs when someone intentionally or knowingly represents another person's words or ideas as his or her own.
3. Collusion involves unauthorized collaboration with another person or group to commit any academically dishonest act.
4. Fabrication occurs when false information is included on a works-cited page.
5. During exams and quizzes, you are **not allowed to use any wi-fi-enabled electronic device**, including cell phones or other electronic communication devices or methods (calculators, wrist watches, earbuds, etc.). No wristwatch or other electronic device may be worn.
6. During exams and quizzes, you are allowed to use only instructor-approved calculators.
7. No electronic version of the book, loose paper print-outs of the book or extra sheets of paper of any kind are allowed unless explicitly mentioned in writing by the instructor. As a part of the zero-tolerance policy, if you have a cellphone or other electronic device capable of communication on your person; or if any proctor sees or hears any electronic device during the exam or if you share your work with someone else, you will be reported to the proper authorities, and you may receive a zero on the exam and an F in the class. Other actions, including suspension, may also be perused

Any act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. Violations will be taken seriously and will be referred to the Office of Student Conduct and Conflict Resolution for possible disciplinary action. Students may be suspended or expelled from UTEP for such actions. You can find more information in the *UTEP Handbook of Operating Procedures*.

UTEP Handbook of Operating Procedures @ https://www.utep.edu/hoop/

Students with disabilities:
Students with disabilities or who suspect they have a disability may wish to self-identify for purposes of modifications. You can do so by providing documentation to the Office of Disabled Student Services located in the UTEP Union. If you have a condition that may affect your ability to exit safely from the premises in an emergency or which may cause an emergency during class, you are encouraged to discuss this in confidence with the instructor and/or director of the Disabled Student Services. For general information about the American with Disabilities Act (ADA), please call 747-5184.

Cell phone policy- Cell phones are to be off during class. You should not take phone calls during class, except for emergencies.

Tentative Schedule & Topics:

Week	Dates	Topic
1	Aug 22 & 24	Syllabus & Introduction
2	Aug 29 & Aug 31	Environmental Standards, GHG Protocol
3	Sept 7	System Tools, LCA – Goal & Scope Definition
4	Sept 12 & 14	LCA – Inventory Analysis
5	Sept 19 & 21	LCA – Impact Assessment
6	Sept 26 & 28	LCA – Interpretation
7	Oct 3 & 5	1st Project Presentation & EXAM
8	Oct 10 & 12	Renewable Energy Systems
9	Oct 17 & 19	Renewable Energy-Bio Energy, Land-Use Change
10	Oct 24 & 26	LCA – Renewable Energy Systems GREET
11	Oct 31 & Nov 2	System Dynamics
12	Nov 7 & 9	System Integration
13	Nov 14 & 16	IPCC, Life Cycle Applications & Research
14	Nov 21 & 23	Dedicated for Final Projects
15	Nov 28 & Nov 30	Final Projects Presentations
16	Dec 5 & 7	Finals Week

Glossary

Cyber-Harassment, or the use of a computer to cause a person harm such as anxiety, distress or psychological harm, including abusive, threatening, or hateful emails and messages and the posting of derogatory information online.

Cyberbullying, or intimidating messages sent directly to the victim via email or other Internet communication mediums, and/or the use of technological means to interfere with a victim's use of the Internet such as hacking or denial of services attacks. This can also include spreading rumors about the victim in internet forums or discussion boards; subscribing the victim to unwanted online services or sending messages to others in the victim's name.

Cyberstalking, or threatening behavior or unwanted advances directed at another using the Internet and other forms of online and computer communications. With personal information becoming readily available to an increasing number of people through the Internet and other advanced technology, state legislators are addressing the problem of stalkers who harass and threaten their victims over the World Wide Web.

Flaming, or hostile and insulting interaction between internet users. It is frequently the result of the discussion of heated real-world issues such as politics, religion, and philosophy, or of issues that polarize subpopulations, but can also be provoked by seemingly trivial differences.

Deliberate flaming, as opposed to flaming as a result of emotional discussions, is carried out by individuals who are specifically motivated to incite flaming. Usually, are subtler than their counterparts, or trolls, who also post inflammatory messages in an online community. Their primary intent is to provoke readers into an emotional response and disrupt normal, on-topic, discussion.

Plagiarism, or the presentation of another person's work as your own, whether you mean to or not (i.e., copying parts of or whole papers off the Internet).

Collusion, or lending work to another person to submit as his or her own.

Fabrication, or deliberately creating false information on a works cited page.

COVID-19 PRECAUTIONS

Please stay home if you: (1) have been diagnosed with COVID-19 (2) are experiencing COVID-19 symptoms. If you are feeling unwell, please let me know as soon as possible, and alternative instructions will be provided. The Student Health Center is equipped to provide COVID 19 testing.

The Center for Disease Control and Prevention recommends that people in areas of substantial or high COVID-19 transmission wear face masks when indoors in groups of people. The best way that Miners can take care of Miners is to get the vaccine. If you still need the vaccine, it is widely available in the El Paso area and will be available at no charge on campus during the first week of classes. For more information about the current rates, testing, and vaccinations, please visit epstrong.org