ChE x98: Principles of Sustainable Engineering

Course description

This course provides future engineers with the knowledge and tools to make engineering decisions and take actions that contribute positively to the economy, society, and environment. The multi-disciplinary and quantitative approach of this course will introduce the Sustainable Development Goals, material and energy flow analysis, life cycle impact assessment, sustainability reporting.

Credit: 3 units (1.5 h lecture, 1 h tutorial, 1.5 h projects/homework, 1.5 h preparatory work)

Prerequisites: 3rd year standing (UG), COI (PG)

Course outcomes

At the end of this course, you should be able to

1. Explain sustainability and the reasons for unsustainability
2. Recognize and communicate sustainability issues
3. Estimate the environmental and economic impacts of material and energy use
4. Interpret life cycle and sustainability reports
5. Propose and evaluate solutions for sustainable products and processes

Course requirements

Discussion forum   25%
This includes participation in course activities and assessments designed to assess your understanding and provide feedback. Rubrics are found at the end of this document.

Case study   15%
This activity involves a critical review of sustainability reports published by a business or organization of your choice. The first part is done in teams preparing a succinct review, while the second part is performed as a small group discussion. The goal of the activity is to exhibit of your reflective learning and the application of concepts from the class to the real world. Rubrics are found at the end of this document.

Quiz   15%
The quiz will assess your ability to use computational methods and evaluate the results. This will be an individual assessment.

Climate action paper   20%
This guided assignment will be posted after completing the activities in week 13.

Class wiki   25%
To be accomplished in teams, the wiki will be worked on throughout the semester. Each team will be tasked to assess a system/technology of their choice according to the principles of sustainable engineering. Rubrics are found at the end of this document.

Grading scale

[90, 100]	[88,90)	[85,88)	[82,85)	[79,82)	[75,79)	[70,75)	[65,70)	[60,65)	[0,60)
1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	5.00

Policies and Guidelines

1. <u>Mode of delivery</u>. All announcements, course materials, and submissions will be made through UVLe and MS Teams. It is advisable to turn on notifications these apps and regularly check your @up.edu.ph emails.

   - UVLe: https://uvle.upd.edu.ph/course/view.php?id=11483
     Mobile app: https://helpdesk.ilc.upd.edu.ph/kb/faq.php?id=14
     Desktop app: https://download.moodle.org/desktop/
   - Zoom: [Confidential link to be sent upon enrolment]
     Getting started: https://itdc.up.edu.ph/uis/how-to-login-to-your-zoom-account

2. <u>Communication plan</u>. MS Teams will be the primarily platform where I can communicate with you regularly. Announcements will be posted at UVLe and MS Teams. You can get in touch through email for urgent/private concerns. Regular interaction with your fellow classmates is also highly encouraged.

3. <u>Teaching strategy.</u> This course uses strategies that seek to put you and your classmates at the center of the learning process. Learning activities are designed based on this principle and are conducted in a manner that will make you engage with the material, with your classmates, and with me. As the student, you are primarily responsible for your own learning. Class participation is essential to achieve the course outcomes.

4. <u>Mitigating circumstances</u>. If you have any condition that can adversely affect your optimal performance in this class, please inform me at the soonest possible time so that we can appropriately address the matter.

5. <u>University values</u>. Please be mindful and practice the values of honor and excellence by

   - Observing academic honesty and the ethics of scholarship
   - Respecting intellectual property rights
   - Being aware that any form of academic honesty results in a final grade of 5.0 and can be subject additional disciplinary measures

References

1. Bakshi, B.R. *Sustainable Engineering: Principles and Practice*. https://doi.org/10.1017/9781108333726

2. Azapagic, A., Perdan, S. *Sustainable Development in Practice, 2nd ed.* https://doi.org/10.1002/9780470972847

3. Matthews, H.S., C.T. Hendrickson, D.H. Matthews. *Life Cycle Assessment: Quantitative Approaches for Decisions that Matter*, https://www.lcatextbook.com/

4. Jolliet, O. et al. *Environmental Life Cycle Assessment*, https://doi-org.ezproxy.engglib.upd.edu.ph/10.1201/b19138

5. Hauschild, M.Z. et al. *Life Cycle Assessment: Theory and Practice*. https://doi-org.ezproxy.engglib.upd.edu.ph/10.1007/978-3-319-56475-3

6. Theis, T. and J. Tomkin. *Sustainability: A Comprehensive Foundation*, https://cnx.org/contents/F0Hv_Zza@45.1:HdWd2hN5.

7. Sachs, J. *The Age of Sustainable Development*. https://cupola.columbia.edu/age-of-sustainable-development/.

8. Fiksel, J. *Design for Environment: A Guide for Sustainable Product Development*. https://www.accessengineeringlibrary.com/content/book/9780071605564

9. Chang, N. *Systems Analysis for Sustainable Engineering: Theory and Applications*. https://www.accessengineeringlibrary.com/content/book/9780071630054

10. Allen, D.T., D. Shonnard. *Green Engineering: Environmentally Conscious Design of Chemical Processes*, Prentice Hall, 2001.

11. Jimenez-Gonzalez, C., D.J.C. Constable. *Green Chemistry and Engineering: A Practical Design Approach*, Wiley, 2011.

12. Stasinopoulos, P., et al. *Whole System Design: An Integrated Approach to Sustainable Engineering*, Earthscan, 2009.

Course Outline

Week	w/c	Topic	Key Questions	Activities	Assessment
1	14-Sep	Introduction and Orientation State of the World	What is this course about? How will we learn in this course? What are the issues surrounding sustainability in today's world?	Student information survey Class introduction Lecture Videos Readings	Discussion forum
2	21-Sep	Sustainability – Definition and Challenges	What is sustainability? How are sustainability issues addressed? What is the role of engineering in sustainable development?	Lecture Videos Readings	Discussion forum
3	28-Sep	Approaches to Sustainability	How has sustainability been studied in various disciplines?	Videos Readings	Discussion forum
4	5-Oct	Participative Discussion of Sustainability Issues	How to we elucidate the sustainability issues of a technology?	DEMOCS activity	Discussion forum
5	12-Oct	Sustainability Reporting 1	How does business and industry report their actions in support of sustainable development?	Reading assignment Literature review	
6	19-Oct	Sustainability Reporting 2	Do actions taken by business and industry promote sustainable development?	Group discussion	Case study report
7	26-Oct	Life Cycle Thinking	What is life cycle thinking? How do we begin a life cycle assessment?	Lecture Tutorial session	Discussion forum
8	2-Nov	Life Cycle Inventory Analysis	How do we establish the life cycle inventory of a product/service?	Lecture Tutorial session	Discussion forum
9	9-Nov	Life Cycle Impact Assessment	How do we evaluate the environmental impacts of a product/service?	Lecture Tutorial session	Discussion forum
10	16-Nov	Software for Life Cycle Assessment	How do we use software tools to aid in life cycle assessment?	Tutorial session	
11	23-Nov	Synthesis: Life Cycle Assessment			Quiz
12	30-Nov	Engineering Sustainable Solutions 1	What frameworks have been used to embed sustainability in engineering?	Lecture Videos Readings	Discussion forum
13	7-Dec	Engineering Sustainable Solutions 2	What actions can we take to tackle climate change?	Climate action simulation	Climate action paper
14	14-Dec	Course Synthesis	What can we do next?	Videos Course feedback	Class wiki

Rubrics: Discussion Forum

CATEGORY	%	4 (Advanced - exceeds expectations)	3 (Competent - meets expectations)	2 (Progressing - does not fully meet expectations)	1 (Beginning - does not meet expectations)
Quality of Content	25	Postings provide comprehensive insight, understanding, and reflective thought about the topic.	Postings provide moderate insight, understanding, and reflective thought about the topic.	Postings provide minimal insight, understanding, and reflective thought about the topic.	Postings provide no evidence of insight, understanding, and reflective thought about the topic.
	20	Information clearly relates to the main topic. It includes several supporting details and/or examples.	Information clearly relates to the main topic. It provides 1-2 supporting details and/or examples.	Information clearly relates to the main topic. No details and/or examples are given.	Information has little or nothing to do with the main topic.
	15	Postings are creatively and fluently written to stimulate dialogue and commentary.	Postings are generally well written with some attempts made to stimulate dialogue and commentary.	Postings are brief and unimaginative, and reflect minimal effort to connect with the audience.	Postings are written in a half-hearted, disjointed manner that reflects no awareness of effective communication.
Length	15	The post is written with exactly the right amount of detail throughout. It does not seem too short nor does it seem too long.	The composition is typically good, though it seems to drag somewhat OR need slightly more detail in one or two sections.	The post seems to need more editing. It is noticeably too long or too short in more than one section.	The post needs extensive editing. It is too long or too short to be interesting.
Grammar and Spelling	5	Authors make no errors in grammar or spelling that distract the reader from the content.	Authors make 1-2 errors in grammar or spelling that distract the reader from the content.	Authors make 3-4 errors in grammar or spelling that distract the reader from the content.	Authors make more than 4 errors in grammar or spelling that distract the reader from the content.
References	15	All sources used are credible and cited correctly.	All sources used are credible and most are cited correctly.	Most sources used are credible and cited correctly.	Many sources are suspect (not credible) AND/OR are not cited correctly.
Comments	5	Writes comments on other students' posts that are consistently positive, respectful, and succinct while providing a meaningful addition to the discussion.	Writes comments on other students' posts that are generally positive, respectful, and add value to the discussion.	Writes comments on other students' posts that are generally positive, and respectful.	

Rubrics: Case Study

	Category	%	4 (Advanced - exceeds expectations)	3 (Competent - meets expectations)	2 (Progressing - does not fully meet expectations)	1 (Beginning - does not meet expectations)
Home Group	Cooperation	10	Always willing to help and do more. Routinely offered useful ideas. Always displays positive attitude.	Cooperative. Usually offered useful ideas. Generally displays positive attitude.	Sometimes cooperative. Sometimes offered useful ideas. Rarely displays positive attitude.	Seldom cooperative. Rarely offers useful ideas. Is disruptive.
	Role fulfillment	15	Participated in all group meetings. Assumed leadership role as necessary. Did the work that was assigned by the group.	Participated in most group meetings. Provided leadership when asked. Did most of the work assigned by the group.	Participated in some group meetings. Provided some leadership. Did some of the work assigned by the group.	Participated in few or no group meetings. Provided no leadership. Did little or no work assigned by the group.
	Contribution	25	Work is complete, well organized, has no errors and is done on time or early.	Work is generally complete, meets the requirements of the task, and is mostly done on time.	Work tends to be disorderly, incomplete, not accurate, and is usually late.	Work is generally sloppy and incomplete, has excessive errors and is mostly late or not at all.
Panel Group: Presentation	Technical content	10	Presenters show mastery of the concepts, including technical correctness.	Presenters show mastery of the concepts.	Presenters show slight mastery of the concepts, missing major points.	Presenters are unclear in explaining concepts.
	Organization	15	Information is organized in a clear, logical way. It is easy to anticipate the type of material that might be on the next slide.	Most information is organized in a clear, logical way. One slide or item of information seems out of place.	Some information is logically sequenced. An occasional slide or item of information seems out of place.	There is no clear plan for the organization of information.
	Visuals	5	Diagrams and illustrations are neat, accurate and add to the understanding of the topic.	Diagrams and illustrations are accurate and add to the understanding of the topic.	Diagrams and illustrations are neat and accurate and sometimes add to the understanding of the topic.	Diagrams and illustrations are not accurate OR do not add to the understanding of the topic.
Panel Group: Discussion	Participation	5	Always listens to, shares with, and supports the efforts of others.	Usually listens to, shares with, and supports the efforts of others.	Often listens to, shares with, and supports the efforts of others.	Rarely listens to, shares with, or supports the efforts of others.
		15	Asks questions that are relevant and informative. Provided effective feedback to other members.	Asks a relevant question. Sometimes talks too much. Provided some effective feedback to others.	Usually does most of the talking–rarely listens to others. Provided little feedback to others.	Asks a question that is irrelevant. Is always talking and never listens to others. Provided no feedback to others.

Rubrics: Class wiki

		TEAM GRADE			
Category	%	4 (Advanced - exceeds expectations)	3 (Competent - meets expectations)	2 (Progressing - does not fully meet expectations)	1 (Beginning - does not meet expectations)
Content	20	Covers topic in-depth with details and examples. Subject knowledge is excellent.	Includes essential knowledge about the topic. Subject knowledge appears to be good	Includes essential knowledge about the topic, but there are 1-2 factual errors.	Content is minimal OR there are several factual errors.
Discussion	20	Provides comprehensive insight, understanding, and reflective thought about the topic.	Provides a moderate amount of insight, understanding, and reflective thought about the topic.	Provides only minimal understanding, or reflective thought about the topic.	Provides no understanding or reflective thought about the topic.
Clarity	10	Explains all ideas clearly and concisely in a logical progression with effective supporting evidence.	Explains most ideas clearly and concisely with supporting evidence.	Incompletely explains ideas and does not effectively use supporting evidence.	Fails to explain ideas clearly, and does not use any supporting evidence.
Composition	5	Presents all information in a style that is appealing and appropriate for the intended audience.	Presents information in a style that is generally appropriate for the intended audience.	Presents information in a style that is often inappropriate for the intended audience.	Presents information in a disjointed, unpolished style which is inappropriate for the intended audience.
Organization	10	Uses a consistent organizational structure that includes grouping related information, defines specialized vocabulary and/or provides a table of contents.	Uses an organizational structure which groups some but not all, related information, defines specialized vocabulary and/or provides a table of contents.	Uses a loosely defined organizational structure which attempts to group similar items.	Fails to provide a consistent organizational structure, and information is difficult to locate.
Layout	10	Makes frequent and effective use of headings, fonts, bullet points and white space to enhance the content's visual appeal and increase readability.	Makes occasional use of headings, fonts, bullet points and white space to enhance the content's visual appeal and increase readability.	Makes minimal use of headings, fonts, bullet points and white space to enhance visual appeal and readability.	Makes no use of headings, fonts, bullet points or white space to enhance visual appeal and readability.
Multimedia	10	Selects high quality graphics and multimedia when appropriate to enhance and clarify the content.	Selects graphics and multimedia which are mostly high quality and enhance and clarify the content.	Selects many low-quality graphics and multimedia which do not enhance the content.	Selects no graphics, or uses only low-quality graphics and multimedia which do not enhance the content.
References	10	Includes links to websites or documents that enhance the information presented.	Includes links to websites or documents, but not all links enhance the information presented.	Includes links to websites or documents which add little value to the information presented.	Does not include any links, or the links selected are of poor quality and do not add any value to the information presented.
Citations	5	Accurately cites all sources of information to support the credibility and authority of the information presented.	Most sources are cited accurately, and support the credibility of the information presented.	Few sources are cited accurately, and they fail to adequately support the credibility of the information presented.	Does not provide any accurate information about sources used.

INDIVIDUAL EVALUATION (applied as a factor to your team grade)					
Category	%	1.1	1.0	0.9	0.6
Contributions, Attitude	15	Always willing to help and do more. Routinely offered useful ideas. Always displays positive attitude.	Cooperative. Usually offered useful ideas. Generally displays positive attitude.	Sometimes cooperative. Sometimes offered useful ideas. Rarely displays positive attitude.	Seldom cooperative. Rarely offers useful ideas. Is disruptive.
Cooperation with Others	20	Did more than others–highly productive. Works extremely well with others.	Did their part of the work-cooperative. Works well with others.	Could have done more of the work–has difficulty. Requires structure, directions, and leadership.	Did not do any work–does not contribute. Does not work well with others.
Focus, Commitment	15	Tries to keep people working together. Almost always focused on the task and what needs to be done. Is very self-directed.	Does not cause problems in the group. Focuses on the task and what needs to be done most of the time. Can count on this person.	Sometimes not a good team member. Sometimes focuses on the task and what needs to be done. Must be prodded and reminded to keep on task.	Often is not a good team member. Does not focus on the task and what needs to be done. Lets others do the work.
Team Role Fulfillment	15	Participated in all group meetings. Assumed leadership role as necessary. Did the work that was assigned by the group.	Participated in most group meetings. Provided leadership when asked. Did most of the work assigned by the group.	Participated in some group meetings. Provided some leadership. Did some of the work assigned by the group.	Participated in few or no group meetings. Provided no leadership. Did little or no work assigned by the group.
Ability to Communicate	15	Always listens to, shares with, and supports the efforts of others. Provided effective feedback to other members. Relays a great deal of information–all relates to the topic.	Usually listens to, shares with, and supports the efforts of others. Sometimes talks too much. Provided some effective feedback to others. Relays some basic information–most relates to the topic.	Often listens to, shares with, and supports the efforts of others. Usually does most of the talking–rarely listens to others. Provided little feedback to others. Relays very little information–some relates to the topic.	Rarely listens to, shares with, or supports the efforts of others. Is always talking and never listens to others. Provided no feedback to others. Does not relay any information to teammates.
Correctness	20	Work is complete, well organized, has no errors and is done on time or early.	Work is generally complete, meets the requirements of the task, and is mostly done on time.	Work tends to be disorderly, incomplete, not accurate, and is usually late.	Work is generally sloppy and incomplete, has excessive errors and is mostly late or not at all.