



# CIEG445/645 – Industrial Ecology (Credits: 3)

## Fall 2021

### T/R 11-12:15, ISE Room 205

## 1. Instructor Information

Jennie Perey Saxe | 343A DuPont Hall | Email: [jpsaxe@udel.edu](mailto:jpsaxe@udel.edu) | 302-831-2446

[LinkedIn](#) | [Instagram @ProfSaxe](#) | [Faculty profile](#) | [Website](#)

Office hours:

**Scheduled in-person: M & W 10:30-11:30 am**

**Scheduled virtual via gather.town ([link](#)): T 4:30-5:30 pm** (day/time may change based on student need; or an additional virtual day/time may be added)

**Drop-in:** anytime I'm in my office

**By appointment:** I encourage you to send me an email to schedule an appointment if the times above do not work for you

*Welcome to Industrial Ecology! Sometimes called “the science of sustainability”, we will covers topics related to environmental science, engineering, and policy. Some of these topics might be familiar, some will be new to you, and some topics will be a new spin on things you have encountered before. Following the flow of materials and looking for opportunities to “close loops” will be a theme throughout the semester.*

## 2. Course Description

This course focuses on environmental issues related to industry and society. Life cycle analysis and other tools are used to examine material and energy flows and the impact of humans and industry on the environment. Topics include: pollution prevention strategies, environmental management systems, and sustainable built environments.

The course will incorporate active discussion of reading assignments from the textbook as well as relevant journal articles. Students will also develop a project to examine a topic using industrial ecology and related principles.

## 3. Learning Outcomes

By the end of this course, students will be able to:

- Define industrial ecology
- Identify ways in which environmental engineering relates to the field of industrial ecology
- Analyze environmental problems using life cycle assessment, pollution prevention, and other industrial ecology principles
- Formulate solutions to environmental problems using sustainability principles

This course is also intended to meet the following ABET Student Outcomes:

- 2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- 4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which much consider the impact of engineering solution s in global, economic, environmental, and societal contexts
- 7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

## 4. Learning Resources

### Required Learning Materials

TEXTBOOK: Industrial Ecology and Sustainable Engineering (Graedel & Allenby). ISBN 9780136008064. A copy is on reserve at Morris Library. You may find other versions online, however, you will be expected to complete reading and problems assigned for this edition of the text.

### Technology

The course will use the Canvas LMS. Information on how to use Canvas is available through the [Canvas Student Guide](#). The instructor will also use Poll Everywhere (<https://sites.udel.edu/ats/polleverywhere/>) during class. To participate in these polls, you may use your cell phone or laptop to access the poll questions.

### Additional Learning Resources

Additional resources will include journal articles and reports which are accessible through the [UD Library website](#) and Canvas.

## 5. Assessment

### Final Grade Breakdown

The final course grade will be calculated using the following categories. **Please note the differences between the 445 and 645 sections.**

Course Component	% of grade
<b>Homework assignments</b> (approx. 5 throughout the semester) <b>The format for the CIEG645 section HW will vary slightly from that of the CIEG445 HW.</b> You may work in groups of 2 to 4 on homework assignments. Each student must turn in one assignment; <u>if you worked with other students, please indicate who you worked with</u> . Each assignment is due at the beginning of class, one week from the day it is assigned (unless otherwise announced).	30%
<b>Midterm</b> <b>The format for the CIEG645 section exam will vary from that of the CIEG445 exam.</b> This exam will be closed-book and will be held in class. You should bring a calculator and blank paper. No access to any wireless network is permitted. All electronic devices must be turned off during exam or your exam will not be accepted.	15%
<b>Project</b> ( <i>Details on the project will be provided in class.</i> ) 445: You will work in teams on a project related to industrial ecology. 645: You will work independently on a project related to industrial ecology.	20%
<b>Final exam</b> The final exam will follow the same format as the mid-term exam. The final exam will cover material not covered on the midterm exam (i.e., it is not cumulative).	15%
<b>Engagement</b> Engagement activities include end of module "lost and found" assignments, discussion questions, and other online activities. Your engagement score will be calculated by dividing the number of points earned by the number of points available.	10%
<b>Reading journals</b> Complete 5 reading journals over the course of the semester. See reading journal assignment on Canvas for full details.	10%

<p><b>Optional extra credit case study (445 only)</b> Up to 10 additional points are available for students that research and make a brief presentation on an industrial ecology case study or topic that is connected to course material. Details will be provided in class.</p>	<p>Up to 10 points added to final exam grade.</p>
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**Late policy: If your assignment may be late, communication with the instructor – in advance – is strongly encouraged.** Late homework assignments will lose 20% per day. 5 calendar days from the due date, a late assignment will be considered missing and will not be accepted or graded. Homework will not be accepted after solutions are posted on Canvas.

**Questions about grading:** If you have a question about grading of (i.e., points awarded/deducted) a homework assignment, exam, or other activity, see the instructor within one week of receiving the graded assignment. After one week, no grade changes will be entertained.

## Grading Scale

Students will be assigned the following letter grade, based on the calculation coming from the course assessment section.

Grade	Interval		Grade	Interval		Grade	Interval
A	94.50 and over		B-	79.50 to 82.49		D+	66.50 to 69.49
A-	89.50 to 94.49		C+	76.50 to 79.49		D	62.50 to 66.49
B+	86.50 to 89.49		C	72.50 to 76.49		D-	59.50 to 62.49
B	82.50 to 86.49		C-	69.50 to 72.49		F	Below 59.49

## 6. Course Calendar and Assigned Reading

“Chapter” readings are from the Graedel and Allenby textbook. Other readings refer to papers available on the course Canvas site under the Reading Assignments and Journals module.

Students will be assigned to 1 of 3 reading groups. Students should come to class prepared to discuss the assigned reading, below, on the date indicated. Discussion questions for reading assignments will be posted on Canvas. Reading journal entries (see “Assessment” section, “engagement” component) will be based on these discussion questions.

**For homework and exams, everyone will be responsible for all textbook reading assignments.**

The reading groups are named after three women involved in industrial ecology and environmental protection:

- Marian Chertow, Yale University, a leader and researcher in industrial symbiosis ([learn more](#))
- Ellen MacArthur, founder of the circular economy-focused Ellen MacArthur Foundation ([learn more](#))
- Rachel Carson, nature writer, author of *Silent Spring* ([learn more](#))

Any changes to this schedule will be communicated with the class. (Link to the [official UD academic calendar.](#))

Week of	Theme/Topic	Reading assignments
8/30	<b>Module 1</b> Introduction Course overview Origins of industrial ecology	<b>Everyone</b> (to be read for first homework): Chapter 1 (Humanity and Technology)

Week of	Theme/Topic	Reading assignments
	Industrial ecology and sustainability	<b>Everyone</b> (to be read for first homework): Chapter 2 (The Concept of Sustainability) Chapter 3 (Industrial Ecology and Sustainable Engineering Concepts) <b>Marian group:</b> Ehrenfeld (2004) <b>Ellen group:</b> Dangelico & Pujari (2010) <b>Rachel group:</b> Frosch and Gallopoulos (1989)
9/6	Industrial ecosystems and the biological analogy	<b>Marian group:</b> Chapter 4 (The Relevance of Biological Ecology to Industrial Ecology) Layton et al (2016) <b>Ellen group:</b> Chapter 5 (Metabolic Analysis) Liwarska-Bizukojc et al (2009) – sections 1-2 <b>Rachel group:</b> Chapter 16 (Industrial Ecosystems) vanBeers et al (2007)
9/13 & 9/20 & 9/27	<b>Module 2</b> Material flow analysis Industrial ecology models	<b>Everyone:</b> Schmidt (2008, Part I) <b>Marian group:</b> Chapter 8 (Sustainable Engineering) <b>Ellen group:</b> Chapter 17 (Material Flow Analysis) <b>Rachel group:</b> Chapter 22 (Modeling in Industrial Ecology)
	<b>Module 3</b> Materials flow – metals, minerals, carbon	<b>Everyone:</b> Chapter 24 (The Status of Resources) <b>Marian group:</b> Laurence (2011) <b>Ellen group:</b> Gsodam et al (2014) <b>Rachel group:</b> IPCC Chapter 6 (Sections 6.1 and 6.5 only)
9/27 & 10/4	<b>Module 4</b> Energy flow	<b>Everyone:</b> Chapter 19 (Energy and Industrial Ecology) Lowenthal and Kastenber (1998)
10/4 & 10/11	<b>Module 5</b> Life cycle assessment	<b>Everyone:</b> Chapter 12 (An Introduction to Life Cycle Assessment) Chapter 13 (The LCA Impact and Interpretation Stages) Rana et al (LCA of cotton, section 9.2-end)
<b>Exam 1 (Modules 1-4) on Thursday, 10/14</b>		
10/18	<b>Module 6</b> Systems analysis Environmental management systems	<b>Marian group:</b> Chapter 26 (Industrial Ecology and Sustainability in the Corporation) <b>Ellen group:</b> Chapter 2 from Jacobsen (2011) <b>Rachel group:</b> Chapter 15 (Systems Analysis)
	Pollution prevention	<b>Marian group:</b> Ozturk et al (2016) <b>Ellen group:</b> Chapter 20 (Water and Industrial Ecology) <b>Rachel group:</b> Galeazzo et al (2014)
10/25	<b>Module 7</b> Product development and Design for X	<b>Marian group:</b> Lewis (Packaging for Sustainability - Chapter 2) <b>Ellen group:</b> Chapter 9 (Technological Product Development) <b>Rachel group:</b> Chapter 10 (Design for Environment and Sustainability: Customer Products)
11/1	Biomimicry	<b>Marian group:</b> Chen et al (2015) <b>Ellen group:</b> Kennedy and Marting (2016) <b>Rachel group:</b> Nagel et al (2010)
11/1 & 11/8	<b>Module 8</b> Eco-industrial parks	<b>Everyone:</b> Geng et al (2008) Liwarska-Bizukojc et al (2009) – sections 3-end

<b>Week of</b>	<b>Theme/Topic</b>	<b>Reading assignments</b>
11/8 & 11/15	Circular economy	<b>Everyone:</b> Brears – Chapters 1 & 11 (2018)
11/22	<b>Thanksgiving break</b>	
11/29	<b>Project presentations</b>	
12/6	<b>Course review</b>	
<b>Exam 2 (Modules 5-8) on Thursday, 12/9</b>		

*My lectures and course materials (syllabi, PowerPoint presentations, exams, homework assignments, video recordings, and similar materials) are protected by U.S. copyright law. You may take notes and make copies of course materials for your own personal use or for another student who is registered and enrolled in this course. You may not reproduce, distribute, or display via posting or uploading lecture notes/recordings/other course materials in any other way without my express written consent, nor may you allow others to do so. Doing so may be in violation of the University of Delaware student code of conduct. (Language adapted from UC Santa Cruz.)*

# 7. Course Policy Document

## Instructor Policies

The instructor has a goal of maintaining an inclusive and engaging classroom environment. Dialogue and questions are encouraged, as is respect for students and the instructor, in both in-person and online discussions. **Cell phone use is permitted for answering poll questions. For non-polling portions of class meetings, please do not use cell phones or earbuds out of respect for your instructor and classmates.** The use of laptops for notetaking or class activities is permitted.

Every effort will be made to avoid changing the course schedule but the possibility exists that unforeseen events will make changes necessary. The instructor reserves the right to make changes to the syllabus as deemed necessary. Students will be notified in a timely manner of any syllabus changes via announcements on the course Canvas site. Please make sure your settings on Canvas are set to send you emails of posted announcements.

## Communication

**When in doubt, communicate.** Messages to the class will typically be sent as Announcements through Canvas; please check your Canvas settings to ensure you receive these messages. In addition, communication via email and phone, or in person during office hours or during a scheduled appointment, are all welcomed modes of communication from students. All emails will be responded to, however, please do not expect that email will be returned immediately.

## Attendance

**In-class activities are specially designed to help students achieve learning objectives.** Attendance is critical to achieve the course learning objectives. However, absence and tardiness are not acceptable reasons for late or missing assignments. **Communication is critical in regard to attendance.** Let the instructor know in advance if you anticipate missing a class. **If you feel ill, please stay home.**

Absences on religious holidays listed in university calendars are recognized as an excused absence. Nevertheless, students are urged to remind the instructor of their intention to be absent on a particular upcoming holiday. Absences on religious holidays not listed in university calendars, as well as absences due to athletic participation or other extracurricular activities in which students are official representatives of the university, shall be recognized as excused absences when the student informs the instructor in writing during the first two weeks of the semester of these planned absences for the semester.

## Student Mental Health & Wellbeing

In addition to impacting your overall well-being, diminished mental health can interfere with optimal academic performance. If this course is causing or contributing significant mental or emotional stress, then please reach out to me directly. However, problems with other parts of your life can also contribute to decreased academic performance. UD's Center for Counseling & Student Development (CCSD) provides cost-free and confidential mental health services to help you manage personal challenges that threaten your emotional or academic well-being. Remember, getting help is a smart and courageous thing to do -- for yourself and for those who care about you.

- **Contact me:** If you are struggling with this class, please check-in during office hours or contact me by email at [jpsaxe@udel.edu](mailto:jpsaxe@udel.edu)
- **Check in with your academic advisor:** If you are struggling in multiple classes, unsure whether you are making the most of your time at UD, or unsure what academic resources are available at UD.
- **UD's Center for Counseling & Student Development and UD Helpline:** CCSD is open and available remotely, and 24/7 mental health support remains available on the UD Helpline at 302-831-1001 for any student in need of someone to talk to. Visit [CCSD's website](#) for additional information and resources.
- **UD's Crisis Text Line:** Text "UDTEXT" or "STEVE" at 741741 for students of color to connect with confidential text message support.
- **Division of Student Life:** Explore the Student Life's [Wellbeing webpage](#) for a comprehensive listing of well-being resources, activities and services available to all students.

# UD Policies

## COVID-19 Guidelines

It is expected for all students to abide by the [most current UD policy on wearing of masks and physical distancing](#).

## Academic Integrity

Please familiarize yourself with UD policies regarding academic dishonesty. To falsify the results of one's research, to steal the words or ideas of another, to cheat on an assignment, to re-submit the same assignment for different classes, or to allow or assist another to commit these acts corrupts the educational process. Students are expected to do their own work and neither give nor receive unauthorized assistance. Complete details of the university's academic integrity policies and procedures can be found at [sites.udel.edu/studentconduct/sgup/](https://sites.udel.edu/studentconduct/sgup/). Office of Student Conduct, 218 Hullihen Hall, (302) 831-2117. E-mail: [student-conduct@udel.edu](mailto:student-conduct@udel.edu)

## Harassment and Discrimination

The University of Delaware works to promote an academic and work environment that is free from all forms of discrimination, including harassment. As a member of the community, your rights, resource and responsibilities are reflected in the non-discrimination and sexual misconduct policies. Please familiarize yourself with these policies at [www.udel.edu/oei](http://www.udel.edu/oei). You can report any concerns to the University's Office of Equity & Inclusion, at 305 Hullihen Hall, (302) 831-8063 or you can report anonymously through UD Police (302) 831-2222 or the EthicsPoint Compliance Hotline at [www1.udel.edu/compliance](http://www1.udel.edu/compliance). You can also report any violation of UD policy on harassment, discrimination, or abuse of any person at this site: [sites.udel.edu/sexualmisconduct/how-to-report/](https://sites.udel.edu/sexualmisconduct/how-to-report/)

## Faculty Statement on Disclosures of Instances of Sexual Misconduct

If, at any time during this course, I happen to be made aware that a student may have been the victim of sexual misconduct (including sexual harassment, sexual violence, domestic/dating violence, or stalking), I am obligated by federal law to inform the university's Title IX Coordinator. The university needs to know information about such incidents to, not only offer resources, but to ensure a safe campus environment. The Title IX Coordinator will decide if the incident should be examined further. If such a situation is disclosed to me in class, in a paper assignment, or in office hours, I promise to protect your privacy--I will not disclose the incident to anyone but the Title IX Coordinator.

For more information on Sexual Misconduct policies, where to get help, and reporting information, please refer to [www.udel.edu/sexualmisconduct](http://www.udel.edu/sexualmisconduct). At UD, we provide 24/7/365 crisis assistance and victim advocacy and counseling. Contact 302-831-1001 to get in touch with a sexual offense support advocate, as well as confidential and anonymous counseling services for other concerns.

## Accommodations for Students with Disabilities

Any student who thinks he/she may need an accommodation based on a disability should contact the Office of Disability Support Services (DSS) office as soon as possible. Students who have documentation of their need for accommodation should register via the SAM platform: [andes.accessiblelearning.com/UDEL/](https://andes.accessiblelearning.com/UDEL/). Reach DSS in the following ways: Phone: 302-831-4643, fax: 302-831-3261, [DSS website](#). Email: [dssoffice@udel.edu](mailto:dssoffice@udel.edu) or visit at 240 Academy Street, Alison Hall Suite 130. Note: During Covid-19 response call ahead to schedule an appointment to come to office

## Non-Discrimination

The University of Delaware does not discriminate against any person on the basis of race, color, national origin, sex, gender identity or expression, sexual orientation, genetic information, marital status, disability, religion, age, veteran status or any other characteristic protected by applicable law in its employment, educational programs and activities, admissions policies, and scholarship and loan programs as required by Title IX of the Educational Amendments of 1972, the Americans with Disabilities Act of 1990, Section 504 of the Rehabilitation Act of 1973, Title VII of the Civil Rights Act of 1964, and other applicable statutes and University policies. The University of Delaware also prohibits unlawful harassment including sexual harassment and sexual violence.

For inquiries or complaints related to non-discrimination policies, please contact: Office of Equity & Inclusion- [oei@udel.edu](mailto:oei@udel.edu), 305 Hullihen Hall Newark, DE 19716 (302) 831-8063. For complaints related to Section 504 of the Rehabilitation Act of 1973 and/or the Americans with Disabilities Act, please contact: Office of Disability Support Services, [dssoffice@udel.edu](mailto:dssoffice@udel.edu), Alison Hall, Suite 130, Newark, DE 19716 (302) 831-4643 OR contact the [U.S. Department of Education - Office for Civil Rights](#)