PURDUE UNIVERSITY | College of Engineering

Engineering Faculty Document No.: 88-26
November 13, 2025

TO: The Engineering Faculty

FROM: The Faculty of the Lyles School of Civil and Construction Engineering

RE: New graduate course – CCE 55800 – Plastics in Infrastructure and the Environment

The Faculty of the Lyles School of Civil and Construction Engineering has approved the following new graduate course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

FROM:

CE 59700 Plastics in Infrastructure and the Environment

Summer 2024 (18); Summer 2023 (20); Summer 2022 (24); Summer 2021 (18)

No Prerequisites

TO:

CCE 55800 – Plastics in Infrastructure and the Environment

Spring, Summer, or Fall

Three total credits

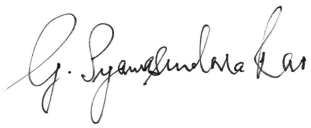
No Prerequisites

Description: Credits: 3.0. During this course, you will examine the fundamental concepts that are the foundation of polymer science and engineering and gain an appreciation of the field's complexity and multidisciplinary nature. This course is designed for civil and environmental engineering disciplines, but content and lessons also will benefit students from other science and engineering specialties. Simplistically, designing, manufacturing, and utilizing materials that contain polymers combine the tools of chemistry, biology, physics, and calculus and is an ever expanding field with its scope expanding daily. Through this course, you will be provided an understanding of fundamental chemical, physical, and thermal characteristics of polymeric materials, basic understanding of material characterization methods, and degradation modes and mechanisms. Students are encouraged to include their undergraduate and graduate level research experiences as well as work experiences into this course. Students who complete this course will have knowledge pertinent in the polymer science and engineering field as well as knowledge applicable to the disciplines of chemistry, biology, environmental science, toxicology, material science, and public health.

RATIONALE:

As we move towards a more sustainable society, it is becoming increasingly important that scientists and engineers hold a basic knowledge of what plastics are, how they degrade, and how they interface with the infrastructure and the environment. Plastics are polymers and polymers have been used for many

years in civil and environmental engineering applications to include landfill liners, utility pipelines, drainage pipes, environmental sampling and analyses such as containers and SPME. Polymers are also being used in our everyday commodities (i.e., cars, food packaging, recreation equipment, and even during medical procedures). Through this course, students will gain an appreciation of the complexity of issues surrounding polymers in civil and environmental engineering.



Head/Director of the Lyles School of Civil Engineering

Link to Curriculog entry: https://purdue.curriculog.com/proposal:29009/form

CCE 55800: Plastics in Infrastructure and the Environment

Course Information

- CRNs: 29251-EPE, 31437-OL1
- Instructional Modality: Async-Online
- Course credit hours: 3 credits

Instructor

- Andrew Whelton
  - *Professor of Civil Engineering and Environmental and Ecological Engineering, Purdue University*
  - Email: awhelton@purdue.edu

Welcome

Welcome to the course! I am excited to be your instructor for this course. As we move towards a more sustainable society, it is becoming increasingly important that scientists and engineers hold a basic knowledge of what plastics are, how they degrade, and how they interface with the infrastructure and the environment. Plastics are polymers and polymers have been used for many years in civil and environmental engineering applications to include landfill liners, utility pipelines, drainage pipes, environmental sampling and analyses such as containers and SPME. Polymers are also being used in our everyday commodities (i.e., cars, food packaging, recreation equipment, and even during medical procedures). Through this course, students will gain an appreciation of the complexity of issues surrounding polymers in civil and environmental engineering.

Course Description

During this course, you will examine the fundamental concepts that are the foundation of polymer science and engineering and gain an appreciation of the field's complexity and multidisciplinary nature. This course is designed for civil and environmental engineering disciplines, but content and lessons also will benefit students from other science and engineering specialties. Simplistically, designing, manufacturing, and utilizing materials that contain polymers combine the tools of chemistry, biology, physics, and calculus and is an ever expanding field with its scope expanding daily.

Through this course, you will be provided an understanding of fundamental chemical, physical, and thermal characteristics of polymeric materials, basic understanding of material characterization methods, and degradation modes and mechanisms. Students are encouraged to include their undergraduate and graduate level research experiences as well as work experiences into this course.

Students who complete this course will have knowledge pertinent in the polymer science and engineering field as well as knowledge applicable to the disciplines of chemistry, biology, environmental science, toxicology, material science, and public health.

Prerequisites

Above all, a strong work ethic and committed desire to learn are critical for succeeding in this course. This course also requires a basic understanding of chemistry, biology, physics, and willingness to learn new concepts and work with others. Persons who are lacking part of the academic prerequisites can succeed in this course, but will need to put forth additional effort. Must have a basic understanding of chemistry.

Course Learning Outcomes

The goal of this course is for students to gain a fundamental understanding of polymer science and engineering so they can apply their knowledge to polymer material design, selection, condition assessment, service-life prediction, environmental health and safety, and waste management.

After completing this course, you will be able to:

- Explain the fundamental properties of polymer materials.
- Recognize the chemical, structural, thermal, and mechanical differences between polymeric materials.
- Recognize advantages and disadvantages of polymer materials for civil and environmental engineering applications.

Learning Resources, Technology & Texts

- **Recommended readings:**
  - **Polymer Science and Technology** by Joel R. Fried (3rd Edition), published by Prentice Hall 2014. ISBN-13: 9780137039555. ISBN-10: 0137039557
  - **Polymers and The Environment** by Gerald Scott, published by Cambridge: RSC 1999. ISBN-13: 9780854045785. ISBN-10: 0854045783
  - **Plastics in the Environment** edited by Alessio Gomiero; individual chapters available here.
  - **Introduction to Polymers** from The Open University; resource available here.
- **Other Publications**
  - One part of this course will involve the finding of publications available at scientific journals. Purdue registered students have access to this material for free through Purdue Libraries. Google Scholar may also have freely available files for download/access. ***Students should not pay to purchase an article on these journals.***
    - *Environmental Science & Technology*
    - *Water Research*
    - *Environmental Science: Water Research and Technology*
    - *AWWA Water Science*
    - *Environmental Pollution*
    - *Waste Management*
    - *Recycling, Conservation, and Recovery*
    - *Polymer Degradation and Stability*
    - *Composites*
    - *ASCE-Journal of Environmental Engineering*

- **Use of artificial intelligence (AI) or Large Language Models (LLM) in this course:**
  This policy applies only for our course. Other courses may have policies that are different. Since AI is a rapidly emerging tool, policies on its use are emerging. Accordingly, the course policy may be modified during the semester and students will be notified of any changes.
  If you submit work with your name as the author, then the work must be comprised of your own ideas translated into writing. Whenever there are multiple authors each author is recognized for their contributions with authorship credit. In this emerging era of Large Language Models that can produce text we must adapt accordingly. Therefore, any work submitted with contributions from AI tools must be disclosed or acknowledged.
  Plagiarism is using other's work and claiming it as your own. Stated another way, plagiarism is using someone else's work and failing to give them credit. Plagiarism can include taking words, ideas, images or data that are not created by you. In order to be able to claim authorship with work incorporating AI tools, you will need to be able to clearly identify or articulate your intellectual contribution to the work. If you have not made substantive intellectual contribution to the work you cannot ethically claim authorship.
  Why are we exploring AI? AI tools are emerging very rapidly. It is highly likely that AI tools will have roles in the work place of the future. Gaining experience using AI tools now will likely benefit you. A key idea to always be considering is this: What intellectual contribution can I as a human being bring to AI enhanced work products?
  In this class, always keep a copy of your prompts and the original output of AI. Do not depend on the AI tool to maintain this record for you. Keep your own copy of prompts and output archived in your own computer files. You may be requested to submit these records.
- **Experiment Materials**
  You will conduct one at-home experiment during this course. In order to successfully complete this experiment, you will need to gather the materials listed below:
  - Two (2) kinds of cheese (i.e., Velveeta® or similar) in the shapes shown in the image below. (NOTE: Tofu may be used instead of cheese.) The Velveeta® cheese block, used as an example in the figure, had dimensions of 7.5 cm length x 7.0 cm width x 4.0 cm height. The cheese obtained by the student may have different dimensions which is why student measurements are important.
  - A flat plate which can fully cover the top area of cheese (such as a hard food container lid).
  - Heavy flat material (i.e., large soup can, 400 grams or heavier). This will be the weight placed on the plate (which will be on top of the cheese) for the experiment.
  - Ruler or tape measure to measure the cheese height. When the weight is placed on top of the cheese the height should decrease and increase based on the actions taken by the student.
  - Stopwatch or timer to keep track of the time when the experiment begins and to prompt the student to take measurements at different times during the experiment.
  - A solid surface such as a tabletop to place the cheese.
  - A writing utensil and paper to record the results.

Grading

This course will be graded based on the following criteria:

Assessment Type	Description	% of Final Grade
Reflections	There will be three (3) reflections. You will receive points for engaging with each reflection prompt. Your reflections must be between 250 and 500 words.	10%
Experiment	There will be one (1) experiment that you will need to complete at home. In order to successfully complete this experiment, you will need to gather the materials listed above. You will document the results of this experiment and submit them online.	20%
Quizzes	There will be eight (8) quizzes. Quizzes will be multiple choice. You will have two attempts to complete each quiz.	40%
Case Studies	There will be six (6) case studies. You are encouraged to complete the case studies as you encounter them throughout the course; however, they are not due until the last day of the course (see the schedule below for due dates). Case studies will include several resources for you to review and multiple choice questions, worth one point each. You will have two attempts to complete each quiz.	30%

Grading Scale

Your course grade will be based on the following grading scale: 93-100% A; 90-93% A-; 87-90% B+; 83-87% B; 80-83% B-; 77-80% C+; 73-77% C; 70-73% C-; 67-70% D+; 63-67% D; 60-63% D-; <60% F.

Grades will be rounded to the nearest whole integer. One decimal place will be used. If 0.5 or greater, the integer would be rounded up. For example, an 83.5 is rounded to an 84. Though, an 83.4 is not rounded up. It is rounded down to an 83.

Course Content and Activities

Section	Suggested Dates*	Module	Assignments
1	5/13-5/26	1. Introduction to Plastics 2. Introduction to Chemical Properties 3. Chemical Properties 4. Unique Properties of Polymers 5. Copolymers and Proteins	• **Reflection 1** o Due: **Sunday, 5/26, 11:59 PM ET** (*5/27, 03:59 UTC)* • **Quiz 1** o Due: **Sunday, 5/26, 11:59 PM ET** (*5/27, 03:59 UTC)* • **Quiz 2** o Due: **Sunday, 5/26, 11:59 PM ET** (*5/27, 03:59 UTC)*
2	5/27 – 6/9	6. Polymer Size, Shape, Terminology, and Solubility 7. Semi-crystalline Polymers 8. Viscoelasticity 9. Viscoelastic Experiment 10. Degradation	• **Reflection 2** o Due: **Sunday, 6/9, 11:59 PM ET** (*6/10, 03:59 UTC)* • **Quiz 3** o Due: **Sunday, 6/9, 11:59 PM ET** (*6/10, 03:59 UTC)* • **Quiz 4** o Due: **Sunday, 6/9, 11:59 PM ET** (*6/10, 03:59 UTC)*
3	6/10 – 6/23	11. Scission or No Scission 12. Fracture Mechanics 13. Rubber Behavior 14. Polymer Characterization 15. Polymer Processing and Rheology	• **Experiment Results (Quiz, Measurements, Reflection)** o Due: **Sunday, 6/16, 11:59 PM ET** *(6/17, 03:59 UTC)* • **Quiz 5** o Due: **Sunday, 6/23, 11:59 PM ET** *(6/24, 03:59 UTC)* • **Quiz 6** o Due: **Sunday, 6/23, 11:59 PM ET** *(6/24, 03:59 UTC)*
4	6/24 – 7/7	16. Oriented Structures 17. Composites 18. Plastic Waste 19. Microplastics	• **Reflection 3** o Due: **Friday, 7/5, 11:59 PM ET** *(7/6, 03:59 UTC)* • **Case Studies 1 - 6** o Due: **Friday, 7/5, 11:59 PM ET** *(7/6, 03:59 UTC)* • **Quiz 7** o Due: **Friday, 7/5, 11:59 PM ET** *(7/6, 03:59 UTC)* • **Quiz 8** o Due: **Friday, 7/5, 11:59 PM ET** *(7/6, 03:59 UTC)*

*All course material is available on the first day of the course. However, I have included some suggested review dates here for you to complete the section materials. There are four sections in this course, and I have suggested that you take two weeks to complete each section. The due dates for the reflections, quizzes, and experiment results are ***required***.

Estimated Effort

- Approximately 10 hours per section (4 sections)
- 8 weeks total

Course Help

To get help with course content, comment in the discussion forums. By commenting in these discussion forums, the course team will be able to respond to your question more quickly. During the work week, the course team will respond to your question within 36 hours.

Discussion Guidelines

Please follow the Discussion Guidelines when contributing to discussions in this course. Here are a few of the key points you should remember:

- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular or slang language. This could possibly lead to misinterpretation.
- Do not hesitate to ask for feedback.
- Be concise and to the point.
- Think and edit before you push the "Send" button.

Accessibility Information

Purdue University is committed to making learning experiences accessible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies.

Use of Copyrighted Materials

See the University Policies and Statements section of Brightspace for guidance on Use of Copyrighted Materials. Effective learning environments provide opportunities for students to reflect, explore new ideas, post opinions openly, and have the freedom to change those opinions over time. Students and instructors are the authors of the works they create in the learning environment. As authors, they own the copyright in their works subject only to the university's right to use those works for educational purposes Students may not copy, reproduce, or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites) any work in which they are not the sole or joint author or have not obtained the permission of the author(s).

Mental Health/Wellness Statement

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try Therapy Assistance Online (TAO), a web and app-based mental health resource available courtesy of CAPS**.** TAO is available to you at any time by creating an account on the TAO Connect website, or downloading the app from the App Store or Google Play. It offers free, confidential well-being resources through a self-guided program informed by psychotherapy research and strategies that may aid in overcoming anxiety, depression and other concerns. It provides accessible and effective resources including short videos, brief exercises, and self-reflection tools.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc., sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect.

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.