CEE 401 – Concrete Properties and 3D Printing **Fall 2026**

(Information is subject to change)

Course Summary:

Engineering application of cementitious materials requires a deep understanding of concrete properties and the role of each of its constituents (cements, water, aggregates, and admixtures) and examination of the underlying hydration behavior for desired fresh (workability and placement) and hardened (strength, volumetric stability, and durability) concrete properties. These fundamental topics are reinforced through hands-on laboratory exercises and a concrete 3D printing design challenge.

Class: Lecture 2:00 PM – 2:50 PM; M, W, F Newmark 1311
Lab: M 11-1 PM Newmark 1225

Lab: T 12-2 PM

All lectures and labs will be in-person.

Texts: Mindess, S.; Young, J. F.; and Darwin, D., *Concrete*, 2nd edition, Prentice Hall 2003

Mehta, P. K. and Monteiro, P. J. M., Concrete Microstructure, Properties, and Materials, McGraw-Hill 3rd ed, 2006

Instructor: Prof. Henschen, NCEL 2129D; 217-300-6472; jhensche@illinois.edu
Office Hours: TBD

TA Dominika Dynak, ddynak2@illinois.edu: TBD

Credits: 4 credits

Prerequisite: CEE 300 – Materials Engineering or equivalent

Learning Management:

The course content will be managed on Canvas (canvas.illinois.edu).

Student Outcomes (PO):

The faculty of the Department of Civil Engineering have identified seven student outcomes (PO). These student outcomes are skills that graduates from the civil engineering department will possess upon graduation. This course supports the following program outcomes.

1. **Demonstrate an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.**
3. **Demonstrate an ability to communicate effectively with a range of audiences.**
5. **Demonstrate an ability to function on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.**

6. **Demonstrate an ability to develop and conduct appropriate experimentations, analyze and interpret data, and use engineering judgement to draw conclusions.**
7. **Demonstrate an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.**

Course Objectives:

At the end of the course, students should be able to:

1. Describe the production, reactions, and kinetics of Portland cement.
2. Describe the effects of chemical and mineral admixtures on Portland cement concrete.
3. Describe and apply standard tests to characterize the fresh and hardened properties of Portland cement concrete.
4. Choose mixture proportions to achieve desired fresh and hardened properties.
5. Describe the change of hardened properties of Portland cement concrete over time.
6. Describe various specialized applications of concrete that are still being developed.

Academic Integrity:

Academic integrity is expected; it is the responsibility of the student to refrain from such infractions as cheating, fabrication, and plagiarism in *any* aspect of the course. The definitions of, and university policies on, academic integrity are explained in Article 1, Part 4 of the Illinois student code (http://admin.illinois.edu/policy/code/). Any assignment where plagiarism or other forms of cheating has been determined to occur will receive a score of zero. Any student who has been determined to plagiarize, cheat or fabricate more than once in this class during the course of the semester will receive a failing grade for the course. All questions of academic integrity will be will be handled through the established college of engineering procedure (FAIR system), which follows the student code. Please note the Illinois CEE honor code pledge: *I pledge to uphold the highest levels of professional and personal integrity in all of my actions, including 1) never assisting or receiving unfair assistance during exams, 2) never assisting or receiving assistance on class assignments beyond that specified by an instructor, and 3) always fully contributing to group activities that are part of a course activity.*

Grading:

Exam #1	15%
Exam #2	15%
Exam #3	15%
Final Exam	15%
Homework, quizzes, and class discussions	5%
Lab reports (5% Quiz, 20%WS, 50% Formal, 10% Memo and 15% Present)	15%
Semester Project	20%

Final class grades will be awarded based on the total percentage of points earned:

93-100	A	73-77	C
90-93	A-	70-73	C-
87-90	B+	67-70	D+
83-87	B	63-67	D
80-83	B-	60-63	D-
77-80	C+	<60	F

*Grading scale is subject to change. This represents the highest range. If you reach these ranges you are guaranteed the above grades. However, I reserve the right to lower the ranges as I see fit.

Absences:

You must notify the instructor as soon as possible prior to any anticipated absences. You will be responsible for scheduling alternate times to make up missed work or labs. For unexcused absences, you will not be able to make up any missed assignments. No make-up exams will be given except as required by University Policy. If a make-up exam is given it will be given during exam week.

Homework & Discussions:

There will be three types of assignments in this course; homework, discussions, and lab work. The homework will be due each Friday and is intended to help you review the course content from the lectures and reading. The discussions will encourage you to research content beyond the lectures/reading. There will not be one right or wrong answer in the discussions. The lab work will vary between different writing assignments and will help develop your technical writing skills.

Most weeks, there will be a class discussion on the Canvas discussion board. Each Monday, an open-ended question will be posed related to class material, current events. Each student is responsible for at least 1 response to the posed question and 1 response to their classmate (you are welcome to respond more frequently). Grading will be based on the thoroughness, thoughtfulness, and "good faith effort" of your response.

** For grading of a good faith effort, I will be looking for evidence of effort in your answer. For homework, your response should be related to the content in the question, calculations should be shown, and your answer is complete. Submitting only a few words or a final numerical answer will not receive credit. For the class discussions, your responses should demonstrate original or factually supported thought (you are welcome to cite outside sources). Single word or repeated responses will not receive credit.

Lab Participation and project:

Lab attendance is critical and required for understanding the testing and results that you will need to process for the lab reports. For the first unexcused lab absence, you will receive a zero on the report for that lab. A second missed lab results in a failure of the course.

A significant portion of your grade for the course will be based on a lab project that you will complete as a group. The objective of the project is for you to develop cementitious

mixtures that you will be able to print in the concrete printer. There will be several milestones for the project, and you will need to perform trials and experiment with mixture parameters.

Support Services:

Be sure to work with Disability Resources and Education Services (https://www.disability.illinois.edu/) if you need accommodations. Please be ready to work with the instructor so they can be prepared to meet your needs. Transcription of the lectures will be run in Zoom by default, but if there are questions additional transcription services will be made available.

With all of the challenges students face, maintaining mental health is just as important as your physical health. If you find yourself struggling, please reach out to the University Counseling Center (http://www.counselingcenter.illinois.edu/), and they can coordinate with the instructor in necessary.

Class Cancellation:

Notifications of class cancellations will be made through Canvas announcements with as much advance notice as possible. It will be both posted on Canvas so be sure to have your account set to receive notifications of announcements.

Diversity in the classroom:

Our entire community benefits when individuals from different person, cultural, and disciplinary perspectives are working together. Increasing the diversity of our faculty and students is fundamental to our mission. It improves and accelerates the rate and impact of our academics, research, and reputation.

-Grainger College of Engineering

Classroom Safety

For general classroom safety policies, we will be following the university police's guidance: https://mediaspace.illinois.edu/media/t/1_bbti3ec5

The safety guidelines for the lab will be discussed and documented in your lab session.

AI Usage

In civil and environmental engineering, human oversight is non-negotiable. The safety of our infrastructure, water systems, and environment rely on you. Generative AI tools (ChatGPT, Gemini, etc.) are tools that can help you to be more effective and efficient as an engineer. In this course, you will be encouraged and required to use Generative AI tools at various points. The Generative AI outputs should never be your submitted work unless specifically required. You must submit writing and ideas that are your work and ideas and document where and how you used the tools.

Permitted use: Brainstorming, writing aid for editing
Prohibited use: Generating reflection responses, using AI generated responses as your writing
Transparency: In all of your writing assignments, you need to disclose how and where AI was used in a designated section.