Last updated in Oct. 2025

NPRE 470: Fuel Cells and Hydrogen Sources

Fall 2025

Course Website: https://courses.grainger.illinois.edu/npre470/sp2025/web/NPRE-470.htm

Meeting Times & Location: Tuesdays & Thursdays, 3:30–4:50 p.m. | Engineering Hall 106B8

Credit Hours: 3

Instructor

Instructor: Kyu-Jung Kim

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Office Hours: by appointment

Course Description

Hydrogen is proposed as the foundation of a global energy economy to address supply challenges and environmental goals. This course covers hydrogen production from nuclear and non-nuclear sources, transport, storage, and applications, with a focus on fuel cells. Lectures include hydrogen handling and safety, storage methods, fuel cell science and thermodynamics, and low- and high-temperature fuel cells for portable, automotive, and space applications.

Prerequisites

Junior, senior, or graduate standing, or consent of the instructor.

CHEM 102, MATH 285, and PHYS 212

Learning Objectives

- Explain the principles and challenges of the hydrogen economy.
- Describe methods of hydrogen production, transport, and storage.
- Analyze the electrochemical and thermodynamic processes in fuel cells.
- Compare different types of fuel cells and their applications.
- Evaluate system-level design and performance of hydrogen-based energy systems.

Course Format

This course consists of two 80-minute lectures per week. Coursework includes homework assignments, two midterm exams, and a final group presentation accompanied by a written report. Students are expected to spend approximately 6–8 hours per week outside of class for readings, assignments, and project work.

Learning Resources

Required Textbook:

O'Hayre, R., Cha, S.-W., Colella, W., and Prinz, F. B., **Fuel Cell Fundamentals**, 3rd Edition, Wiley, 2016.

Recommended Textbook:

Andrew Dicks, David James, **Fuel cell systems explained**, 3rd edition, Wiley, 2018

Additional reading materials will be provided via the course website.

Course Requirements

- Assignments: 5 homework sets (40%)
- Midterm Exams: 2 exams (50%)
- Final Project (Term Paper & Group Presentation): 10%
- Participation: 0%

Late Assignment Policy

90% of full credit if submitted within one week of the deadline,
50% of full credit if submitted within two weeks,
No credit will be given for submissions more than two weeks late.

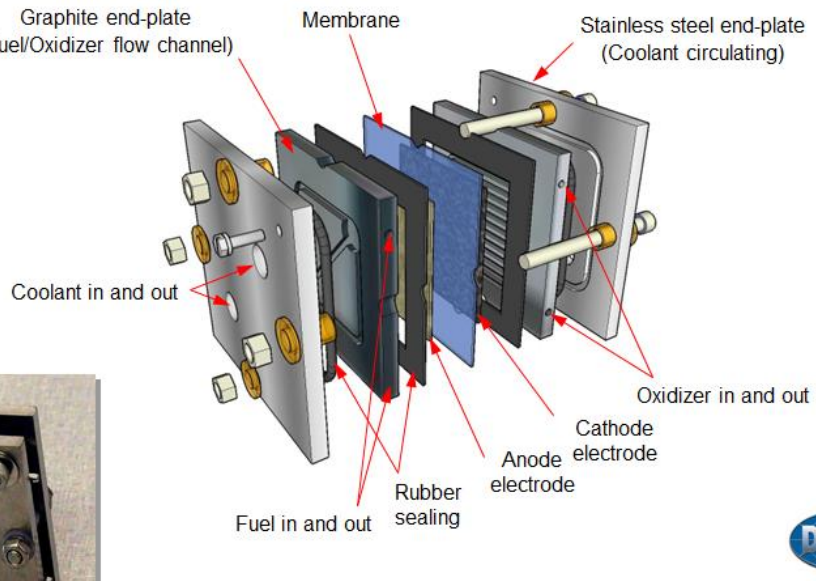
Grading Scale

A+: 100% A: 95–99.99% A–: 91.75–94.99%
B+: 82.25–91.74% B: 75–82.24% B–: 66.75–74.99%
C+: 58.25–66.74% C: 50–58.24% C–: 41.75–49.99%
D+: 33.25–41.74% D: 25–33.24% D–: 16.75–24.99%
F: <16.74%

Course Schedule

1. Course introduction
2. Introduction to the Hydrogen Economy and Fuel Cells
3. Hydrogen Properties and Production
4. Hydrogen Transportation
5. Hydrogen Conversion Technology I: Combustion
6. Hydrogen Conversion Technology II: Metal Hydrides and Applications
7. Fuel Cell Fundamentals – Introduction (Ch. 1)
8. Fuel Cell Thermodynamics (Ch. 2)

9. Fuel Cell Reaction Kinetics (Ch. 3)
10. Fuel Cell Charge Transport (Ch. 4)
11. Fuel Cell Types (Ch. 8)
12. Fuel Cell Systems Overview (Ch. 10)
13. Applications: Stationary, Mobile, Wearable, and Transportation Power
14. Final Presentations



2"x2" of active MEA area
Controlled temperature operation
Designed for MEA and Flow channel optimization study