



Course	ENS 521- Hydrogen Energy System
Instructor	Begüm Yarar Kaplan
Term	2022-2023 Fall
Hours of classroom	<i>Monday</i> 08.40-09.30 (FENS L027) <i>Tuesday</i> 12.40-14.30 (FENS L030)
Zoom link	https://sabanciuniv.zoom.us/j/5271871124

Instructor's Contact Information

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Office hours	Wednesday 15.40-16.30 (but please email me)

General Course Information

Course Description	This course is designed to be an extensive introduction to principles of hydrogen technology, hydrogen production methods, electrolyzers, electrochemistry of energy conversion systems, and fuel cells as the main focus of applications of hydrogen energy.
Objectives	<ul style="list-style-type: none">• To provide a theoretical background which is necessary for the understanding of hydrogen technology and its applications• Identify electrochemical reactions, components of different type of electrolyzers and fuel cells• Understand the working principles, advantages, and challenges of fuel cells• To familiarize the students with application areas of hydrogen technology
Reference Books	<p>There will be no textbook for this course. You can study from lecture notes and reference books on <i>Hydrogen and Fuel Cell Technology</i>. Several examples are given below:</p> <ul style="list-style-type: none">• Zhang, Jiujun, ed. PEM fuel cell electrocatalysts and catalyst layers: fundamentals and applications. Springer Science & Business Media, 2008.• Barbir, Frano. PEM fuel cells: theory and practice. Academic press, 2012.• Lipman, Timothy E., and Adam Z. Weber, eds. Fuel cells and hydrogen production: A volume in the Encyclopedia of sustainability science and technology. Springer, 2019.• Scott, Keith, ed. Electrochemical Methods for Hydrogen Production. Royal Society of Chemistry, 2019.

Grading	<i>Attendance – 5 %</i> <i>Midterm – 20 %</i> <i>Project – 40 %</i> <i>Final exam – 35 %</i>
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Tentative Course Schedule

<i>Date</i>	<i>Topic</i>
October 3 & 4	Introduction to hydrogen technology -Fundamentals, terminology, history of hydrogen technology -General overview: Advantages, current situation of technology and challenges
October 10 & 11	Hydrogen production methods -Clean hydrogen production methods, Electrolyzers -General overview: type of electrolyzers, current status, advantages and challenges
October 17 & 18	Electrolyzers Working principles of different type of electrolyzers, materials for membrane-electrode-assembly of electrolyzers, performance evaluation, electrochemical characterization of PEM and AEM type electrolyzers
October 25 & 26	General principles of electrochemical energy conversion systems -Description of electrochemical cells used for energy conversion -General overview: fuel cells, type of fuel cells, working conditions of different types of fuel cells
October 31 & November 1	Polymer electrolyte membrane (PEM) fuel cells -Detailed description of materials used for membrane-electrode-assembly of PEM fuel cells: membranes, catalysts, and electrodes -Current technology, advantages, and drawbacks
November 7	Polymer electrolyte membrane (PEM) fuel cells -Detailed description of materials used for membrane-electrode-assembly of PEM fuel cells: membranes, catalysts, and electrodes -Current technology, advantages, and drawbacks
November 8	Midterm
November 14	Electrochemical characterizations and performance evaluation of PEM fuel cell components -Detailed description of ex-situ and in-situ electrochemical characterizations with examples
November 15	Anion exchange (AEM) fuel cells

	<ul style="list-style-type: none"> -Detailed description of materials used for membrane-electrode-assembly of AEM fuel cells: membranes, catalysts, and electrodes -Current technology, advantages, and drawbacks
November 21 & 22	<p>Electrochemical characterizations and performance evaluation of AEM fuel cell components</p> <ul style="list-style-type: none"> -Detailed description of ex-situ and in-situ electrochemical characterizations with examples
November 28 & 29	<p>Hydrogen storage methods</p> <ul style="list-style-type: none"> -Materials for hydrogen storage -Hydrogen storage methods for fuel cell applications
December 5 & 6	Applications of fuel cells, current market, and future targets
December 12 & 13	Project Presentations
December 19 & 20	Project Presentations
December 26 & 27	Project Presentations
January 2 & 3	Project Presentations