MSE 466, Spring 2023
Electrochemical Energy Conversion

Time: Tu/Th, 2:00–3:20 pm
Location: 206 Transportation Building
Website: Canvas
Instructor: Prof. Yingjie Zhang, yjz@illinois.edu, 256 MRL
TA/grader: TBD
Office hour: Thursday 1 pm – 1:50 pm (256 MRL)
Credit: 3 undergraduate or graduate hours

Course description: Fundamental mechanism, materials, and device design of electrochemical energy conversion systems such as batteries, fuel cells, electrolyzers, and supercapacitors. Emphasis is placed on the thermodynamics and kinetics of electrode processes, as well as design principles and materials specific issues for renewable energy. This course is intended for both undergraduate and graduate students.

Prerequisite: MSE 304 or any other courses that introduces the electronic structure of materials.

Textbook:

Course Topics:
This course will integrate two aspects of electrochemistry. The first part relates to basic electrochemical principles. The second will discuss electrochemical systems for renewable energy. The two will be integrated wherever appropriate.

1. Fundamentals of Electrochemistry
   Basics of electrochemical cells; redox processes
   Nonfaradaic processes
   Electrode reaction processes; electrodeposition
   Mass transfer
   Thermodynamics of electrochemical cells
   Electrochemical potential
   Kinetics of electrochemical reactions
   Electrocatalysis; Sabatier principle
   Kinetics of water splitting reactions
   Marcus theory of charge transfer

2. Electrochemical Energy Conversion Systems
   Zinc-copper battery
Supercapacitors
Lithium-ion batteries
Redox flow batteries
Design of electrocatalysts
Water electrolyzers
Fuel cells
CO₂ electroreduction to chemicals and fuels

Grading:
Homework assignments  40%
Literature review        20%
Final exam (take home)  40%

Late policy:
Homework, literature review slides, and completed final exams turned in within 24 hours after the deadline will be given 50% score. After 24 hours past the deadline, 0% score will be given.

Policy on conflicts or emergencies:
(1) For time conflicts with other events (e.g. another scheduled exam), or an official UIUC activity (e.g. varsity athletics, band concert), please show official documentation about the conflict at least one week before the homework/report/exam due date. The due date will be extended if the excuses are legitimate.
(2) If you will not be able to make it to the exam or submit HW on time due to serious illness or other emergent personal crisis (e.g. car accident) that are not described in (1), you must send an email to the instructor (yiz@illinois.edu) at your earliest convenience, and submit a statement from the professionals that are authorized to evaluate your situation (e.g. doctors, police officers). The statement needs to clearly explain that you are not physically capable of submitting the HW/report/exam on time. The due date will be extended if the excuses are legitimate.