Syllabus
EN.540.407/540.607/545.607

Renewable Energy Technologies:  
A Chemical Engineering Perspective

Fall, 2021  
(3 credits, EQ)

Description
In this ChemBE course we discuss the principles governing renewable energy technologies, with an emphasis on the fundamental mechanisms from a chemical engineering perspective. Lectures will first be given to introduce state-of-the-art renewable energy technologies, including carbon capture and utilization, solar cells/photovoltaics, batteries, fuel cells/electrolyzers, biomass/biofuels, etc. Discussions will then be carried out to interpret the thermodynamic, kinetic and transport processes governing the energy conversion efficiencies and power performance of such systems. The technical understanding will be followed up with tech-economic and/or life-cycle assessments to evaluate the scalability, commercial viability and environmental sustainability of each technology. Our discussion will be accompanied with reading, survey and presentation of renewable energy research literature with topics identified through group discussions. The final project of the class will be an essay to introduce a technology of interest.

Prerequisites
Engineering Thermodynamics (EN.540.203 or the equivalent)  
Kinetic Processes (EN.540.301 or the equivalent)

Instructor
Professor Chao Wang, chaowang@jhu.edu  
Office: MD 219  
Office hours: Monday morning, 11 am–12 pm

Meetings
Time: Monday, Wednesday, 1:30–2:45 pm  
Where: Shaffer 304

Teaching Assistant
Noah Zecher-Freeman, nzecher1@jhu.edu  
Recitation session: TBD
Reading Materials (optional)


Online Resources
Please log in to the Blackboard for all materials related to this course.

Course Objectives
The goal of this course is to apply the chemical engineering concepts and methodologies to understand the principles of renewable energy technologies.

Course Topics
Part I: Introduction to Renewable Energy
- Energy demand and supply
- History: Fossil fuels vs. renewable energies
- Carbon emission and climate issues

Part II: Fundamentals and Essential Concepts
- Thermodynamics laws
- Phase equilibrium and transition
- Chemical reaction equilibrium
- Chemical reaction kinetics
- Catalysis

Part III: Focused Discussion of Renewable Energy Technologies
- Solar cells and photovoltaics
- Batteries
- Fuel cells
- Biomass and biofuels
- Geothermal energy
- Nuclear power plants
- Hydropower
- Others

Course Expectations & Grading
Homework (every two or three weeks): 30%
Presentation: 30% (15-20 PPT slides, ~20 min)
Essay: 40% (15-20 pages, double space, including >5 figures and >50 references)

Key Dates
Presentation: tentatively arranged in November;
Essay: Due by the end of the semester.
Assignments & Readings
Will be posted on the Blackboard site for this course.

Ethics
The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor.

You can find more information about university misconduct policies on the web at these sites:
• For undergraduates: http://e-catalog.jhu.edu/undergrad-students/student-life-policies/
• For graduate students: http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/

Students with Disabilities
Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Student Disability Services, 385 Garland, (410) 516-4720, studentdisabilityservices@jhu.edu.

Personal Wellbeing
• If you are sick, in particular with an illness that may be contagious, notify me by email but do not come to class. Rather, visit the Health and Wellness: 1 East 31 Street, 410-516-8270. See also http://studentaffairs.jhu.edu/student-life/support-and-assistance/absences-from-class/illness-note-policy/
• All students with disabilities who require accommodations for this course should contact me at their earliest convenience to discuss their specific needs. If you have a documented disability, you must be registered with the JHU Office for Student Disability Services (385 Garland Hall; 410-516-4720; http://web.jhu.edu/disabilities/) to receive accommodations.
• If you are struggling with anxiety, stress, depression or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out our services. The Counseling Center is located at 3003 North Charles Street in Suite S-200 and can be reached at 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/

Classroom Climate
I am committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. I believe fostering an inclusive climate is important because research and my experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me and your peers, and at times this
may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share directly with me. I promise that we will take your communication seriously and to seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the department/center chair/head/director (Paulette Clancy pclancy3@jhu.edu), the Director of Graduate Studies (David Gracias dgracias@jhu.edu), the Assistant Dean for Diversity and Inclusion (Darlene Saporu, dsaporu@jhu.edu), or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g. sexual harassment).

**Student Outcomes**

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. An ability to communicate effectively with a range of audiences

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.