The Hong Kong University of Science and Technology

UG Course Syllabus

Energy Storage Technology

ENEG 4320

3 Credits

2025/26 Fall Term

Monday and Wednesday, 10:30am – 12:00 noon

Room 4504

Instructor: Minhua Shao

Email: kemshao@ust.hk

Office Hours: Room CYT 2006, by appointment.

TA: Kwan Lam Doo, kldoo@connect.ust.hk Room 7102, Monday 4-5 pm

Course Description

This course introduces energy conversion and storage technologies, with primary emphasis on electrochemistry. Designed for senior undergraduate students in science and engineering. We focus on fundamental electrochemical engineering principles and the reaction mechanisms of different technologies. The curriculum includes the design and selection of critical materials and components, as well as consideration of practical applications. After the course, students will possess a comprehensive overview of each technology and an understanding of their respective limitations.

Outline

Introduction to energy conversion and storage (Week 1)

Electrochemical engineering fundamentals (Week 2-4)

Fuel cells (Week 5-6)

Electrolyzer (Week 7)

Lithium-ion batteries (Week 8-9)

Batteries beyond lithium-ion (Li-S, metal-air, etc.) (Week 10)

Photovoltaic cells (Week 11)

CO2 reduction and Super-capacitors (Week 12)

Presentations (Week 13)

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Understand the mechanisms, advantages, and limitations of different energy storage technologies.

2. Identify and evaluate the key materials and components of electrochemical energy storage devices.

3. Describe and assess current research trends in energy storage technologies.

Assessment and Grading

Methodology:

UG & PG:

Lecture notes and final project. For the first part, lecture-based learning will be conducted. All the lecture notes will be posted on the Canvas at least one day before the lecture. The students are responsible for downloading them from the website. Biweekly reading assignments and Homework (literature review) will be assigned after lectures.

There will be a Mid-term exam, but NO Final exam. The Mid-term exam date will be announced later. The Mid-term exam will be open books and notes. However, computers, cell phones or tablets are not allowed during the exam. The mid-term exam will be conducted physically in the classroom.

For the final project, each student will select a topic related to the electrochemical energy conversion and storage and give a 15 min presentation (subject to change dependent on the enrollment of the course) in the last two classes of the semester. The presentation will be delivered physically in the classroom.

PG:

There will be an additional project report (about 3000-4000 words including references) after conducting a literature review. The report due date will be announced later. Plagiarism is prohibited in this class. The report will be automatically rated F once plagiarism is detected.

UG Assessments:

UG Assessment Task	Contribution to Overall Course grade (%)	Due date
Attendance	10%	/
Mid-Term	50%	TBA
Final Presentation	30%	TBA
Homework	10%	TBA

PG Assessments:

PG Assessment Task	Contribution to Overall Course grade (%)	Due date
Attendance	10%	/

Mid-Term	40%	TBA
Final report	25%	TBA
Final presentation	15%	TBA
Homework	10%	TBA

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Attendance	ILO1, ILO2, ILO3.	Attendance helps students understand mechanisms and trade-offs in energy storage (ILO 1), identify and evaluate key materials and components (ILO 2), analyze current research trends and their implications (ILO 3)
Mid-term	ILO1, ILO2, ILO3.	Mid-term exam helps assess students' mastery of knowledge (ILOs 1,2,3), provide learning feedback, and help students understand their strengths and weaknesses, thereby correcting mistakes and consolidating their knowledge.
Final presentation	ILO1, ILO2, ILO3.	The presentation assesses students' ability to critically evaluate different energy storage technologies(ILO 1 and their components (ILO 2) and analyze current energy storage technologies (ILO 3), demonstrating higher-order thinking skills of analysis and evaluation.
Final report	ILO1, ILO2, ILO3.	Final reports help students review different energy storage technologies (ILO 1), enhance their critical thinking skills, ultimately promoting learning and growth. Furthermore, the process of writing a report effectively develops diverse skills, including data collection (ILO 2,3), analysis and summarization, reading comprehension, communication, and note-taking.

Homework	ILO1, ILO2, ILO3.	Homework is designed to assess students' understanding of energy storage technologies (ILO 1) and their ability to describe key material and current research trends in energy storage technologies (ILOs 2, 3), aligning with the skills of remembering and understanding

Grading Rubrics

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of energy storage mechanisms, expertly solves different problems, and shows a strong ability in analyzing and comparing different energy storage technologies. Exhibits strong command of materials and components. Critically evaluates current research and implications.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.]
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.]
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Artificial intelligence tools are allowed to improve language only in the final report.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas. Students who have further questions about the feedback including marks should consult the instructor and TA within a week after the feedback is received.

Resubmission Policy

No resubmission is allowed.

Required Texts and Materials

No text book is required. All the lecture notes can be downloaded from Canvas.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

Additional Resources

Allen J. Bard, et al., Electrochemical Dictionary, Springer, 2012.
Cynthia G. Zoski, Handbook of electrochemistry, Elsevier, 2007.
Jiujun Zhang, et al., Electrochemical Technologies for Energy Storage and Conversion, Wiley, 2011.
Allen J. Bard, Larry R. Falkner, Electrochemical Methods, 2nd edition, John Wiley & Sons, 2001.