**City University of Hong Kong**
**Course Syllabus**

**offered by School of Energy and Environment**
**with effect from Semester A 2024/25**

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## Part I Course Overview

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|---|---|
| **Course Title:** | **Electrochemical Energy Storage** |
| **Course Code**: | **SEE6123** |
| **Course Duration:** | **One semester** |
| **Credit Units**: | **3 credits** |
| **Level**: | **P6** |
| **Medium of Instruction:** | **English** |
| **Medium of Assessment:** | **English** |
| **Prerequisites**: *(Course Code and Title)* | **Nil** |
| **Precursors**: *(Course Code and Title)* | **Nil** |
| **Equivalent Courses**: *(Course Code and Title)* | **Nil** |
| **Exclusive Courses**: *(Course Code and Title)* | **Nil** |

## Part II Course Details

### 1. Abstract

This course provides a comprehensive understanding of the fundamentals and applications of electrochemical systems in energy storage and conversion. It explores the mechanisms, design, and optimization of various electrochemical storage devices, including batteries, fuel cells, electrolyzers, and supercapacitors. Emphasis throughout the course is on understanding the underlying electrochemical processes, materials science, and engineering aspects crucial for the development of efficient, sustainable, and economically viable energy storage solutions. The course is designed to provide students with the essential knowledge required for advancing energy storage technologies.

### 2. Course Intended Learning Outcomes (CILOs)

*(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)*

| No. | CILOs | Weighting (if applicable) | Discovery-enriched curriculum related learning outcomes (please tick where appropriate) | | |
|---|---|---|---|---|---|
| | | | *A1* | *A2* | *A3* |
| 1. | Understand the fundamental principles of electrochemistry relevant to energy storage. | 20% | √ | √ | |
| 2. | Analyze the design, operation, and performance metrics of various electrochemical energy storage systems. | 20% | √ | √ | |
| 3. | Evaluate the material and component choices for different types of energy storage systems and assess their efficiency, durability, and environmental impact. | 20% | √ | √ | |
| 4 | Develop skills in interpreting and critiquing current research and trends in electrochemical energy storage. | 20% | √ | √ | √ |
| 5 | Enhance problem-solving and critical thinking skills within the context of electrochemical energy storage challenges. | 20% | √ | √ | √ |
| | | 100% | | | |

*A1: Attitude*
*Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.*

*A2: Ability*
*Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.*

A3: *Accomplishments*
*Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.*

### 3. Learning and Teaching Activities (LTAs)

*(LTAs designed to facilitate students' achievement of the CILOs.)*

| LTA | Brief Description | CILO No. | | | | | Hours/week (if applicable) |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | **5** | |
| Lectures | | √ | √ | √ | √ | √ | |
| Tutorials | | √ | | | √ | | |

## 4. Assessment Tasks/Activities (ATs)

*(ATs are designed to assess how well the students achieve the CILOs.)*

| Assessment Tasks/Activities | CILO No. | | | | | Weighting | Remarks |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | |
| Continuous Assessment: 100% | | | | | | | |
| Assignments | √ | | √ | | √ | 20% | |
| Midterm | √ | √ | √ | | | 40% | |
| Project Report | | | | √ | √ | 40% | |
| Examination: 0% (duration: , if applicable) | | | | | | | |
| | | | | | | 100% | |

To pass a course, a student must do ALL of the following:

1) obtain at least 30% of the total marks allocated towards coursework (combination of assignments, pop quizzes, term paper, lab reports and/ or quiz, if applicable);
2) obtain at least 30% of the total marks allocated towards final examination (if applicable); and
3) meet the criteria listed in the section on Assessment Rubrics.

## 5. Assessment Rubrics

*(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)*

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

| Assessment Task | Criterion | Excellent (A+, A, A-) | Good (B+, B, B-) | Fair (C+, C, C-) | Marginal (D) | Failure (F) |
|---|---|---|---|---|---|---|
| 1. Assignments | Understanding the basic theory and principles of electrochemistry; capable of rationalizing experimental observations using theory and simple calculations | High | Significant | Moderate | Basic | Falling short of even marginal levels |
| 2. Midterm | Understanding basic principles and capable of explaining experimental phenomena and material properties | High | Significant | Moderate | Basic | Falling short of even marginal levels |
| 3. Project Report | Understanding the key problems of energy storage technologies and capable of proposing potential strategies to solve them | High | Significant | Moderate | Basic | Falling short of even marginal levels |

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

| Assessment Task | Criterion | Excellent (A+, A, A-) | Good (B+, B, B-) | Fair (C+, C, C-) | Marginal (D) | Failure (F) |
|---|---|---|---|---|---|---|
| 1. Assignments | Understanding the basic theory and principles of electrochemistry; capable of rationalizing experimental observations using theory and simple calculations | High | Significant | Moderate | Basic | Falling short of even marginal levels |
| 2. Midterm | Understanding basic principles and capable of explaining experimental phenomena and material | High | Significant | Moderate | Basic | Falling short of even marginal levels |

| | | | | | | |
|---|---|---|---|---|---|---|
| | properties | | | | | |
| 3. Project Report | Understanding the key problems of energy storage technologies and capable of proposing potential strategies to solve them | High | Significant | Moderate | Basic | Falling short of even marginal levels |

**Part III Other Information** (more details can be provided separately in the teaching plan)

## 1. Keyword Syllabus

*(An indication of the key topics of the course.)*

- Electrochemical systems: Fundamentals of electrochemistry, overview of energy storage and conversion.
- Electrochemical principles: electrochemical thermodynamics; kinetics and mechanisms of electrochemical reactions.
- Battery technologies: Principles and types of batteries; lithium-ion batteries; advanced and emerging battery technologies.
- Fuel Cells: Fundamentals and types of fuel cells; electrochemical and materials aspects; applications and challenges.
- Electrolyzers: Principles of electrolysis; hydrogen production and storage; efficiency and optimization.
- Supercapacitors: Basics; materials and performance characteristics; comparison with other storage technologies.
- Applications of electrochemical energy storage: Portable electronics; electric vehicles; grid storage; renewable energy integration.
- Advancements in energy storage technologies: Innovations in materials and processes; challenges and future directions; role in the energy transition.

## 2. Reading List

### 2.1 Compulsory Readings

*(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)*

Nil

### 2.2 Additional Readings

*(Additional references for students to learn to expand their knowledge about the subject.)*

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| 1. | Allen J. Bard, et al., “Electrochemical Methods: Fundamentals and Applications”, 3rd Edition, Wiley, 2022. |
| 2. | Allen J. Bard et al., “Electrochemical Methods: Fundamentals and Applications”, 2nd Edition, Wiley, 2002. |
| 3. | Cynthia G. Zoski, “Handbook of Electrochemistry”, Elsevier, 2007. |
| 4. | Jiujun Zhang, et al., Electrochemical Technologies for Energy Storage and Conversion, Wiley, 2012. |