THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

Introduction to the Subject

Electric Energy Storage and New Energy Sources for Electric Vehicles (EE546)

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Research Centre for Electric Vehicles (RCEV)

Department of Electrical and Electronic Engineering (EEE)

The Hong Kong Polytechnic University

Briefing

Lecturer 1: Dr. Wei Lucian LIU (Subject Leader)

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- **Teaching and learning are mutually motivating**
- Please feel free to give your suggestions on our teaching and learning

Lecturer 2: Dr. Jinpeng TIAN

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Teaching Assistants (TAs):

- Tianyi LIU, andrew-ty.liu@connect.polyu.hk
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Location and Time

Lectures:

- **Location**: ST111
- **Time & Date**: 18:30 – 21:20, Tuesday, 2 Sept 2025 – 25 Nov 2025
- Total number of lectures: 13 (incl. summary and review)

Office hours:

- **Time & Date**: 14:00 – 17:00, Friday
- You may email me in advance to double check my availability.

Introduction to the Subject

Can you answer these? (target questions)

- **How does energy storage play a beneficial role in energy sustainability and addressing the climate change issue?**
- **What types of energy sources are used by electric vehicles (EVs)? And what are the advantages and disadvantages of them?**
- **Which type of energy source do you think is most likely to become mainstream for the EV in the next decade, and why?**
- **What is the hybrid energy system and why do we need it?**
- **What are the potential safety concerns associated with energy storage systems in EVs, and how can they be mitigated?**

Learning Outcomes

- Understand the **importance of energy storage** as it pertains to environmental concerns, energy sustainability and climate change.
- Understand **various underpinning technologies** for conventional and modern energy storage including both portable and stationary systems, such as batteries, supercapacitors, compressed air, flow batteries, new fuel, and fuel cells.
- Explain the **role** of energy storage in new energy in electric vehicles (EV) and discuss how energy storage devices can be optimally **integrated** for these applications.

Energy Storage in EV Technologies

The basic EV parts:

- Conductive charger
- **Battery**
- **Fuel cell**
- **Basic battery management system (BMS)**
- Motor
- Driver

Our Electric Vehicles & Smart Mobility (EVSM) Research Group and Research Centre for Electric Vehicles (RCEV) have the following EV advanced technology:

- Wireless charger
- In-wheel motor & In-wheel vehicle
- All electric active suspension
- **Fuel cell or new fuel vehicle**
- **Distributed energy storage for EV**
- Autonomous vehicle
- Wireless motor
- Wireless EV energy network
- Advanced power electronics technology

What will be taught?

1. Classification of electric vehicle (EV) energy source
2. Batteries
3. Supercapacitors
4. Ultrahigh-speed flywheels
5. Fuel cells
6. Hybridisation of energy sources
7. Case study
8. Magnetic energy storage
9. Lithium-ion batteries and battery management systems
10. Battery models
11. Battery state of charge and state of health
12. Battery impedance and electrochemical impedance spectroscopy
13. New energy for vehicles

The Subject Coursework

Assessment, homework, miniproject, in-class test, and final exam

Assessment & Homework

Assessment

- **Assignment**: 10% (Homework)
- **In-Class Test**: 25% (Two 60-min in-class short tests, each test 12.5%)
- **Miniproject**: 15% (Report and presentation)
- **Examination**: 50% (One three-hour examination)

Homework

- The assignment may be **given after some lectures** as homework.
- The assignment should be returned to the lecturer through **BLACKBOARD** at the following lecture.
- The **deadline** for each homework is specified in the schedule (see **Subject Description**).
- **Rubrics**: All problems must be supported with an appropriate amount of work. Generally, this means that enough work is shown to demonstrate that the student worked through all steps of the problem. Answers without supporting work will receive no credit.

Miniproject

- Students will be divided by themselves into around 9 **miniproject topics** (**each topic can have at maximum 4 groups**, and **each group is around 3-5 students**)
- Each group **selects a project** from the miniproject list
- In each class, we could accommodate **3 to 4 presentations**
- Students will then present the project and submit the **report** (**10 – 20 pages**) two week (i.e. **10 working days**) after the presentation
- **Rubrics**: Presentation skill, report's technical content, and impact. Each group may have the same topic but their content, focus and presentation are different.

Miniproject List

- Start-of-the-Art Batteries for EVs
- Supercapacitor Technology in EVs
- Flywheels & Fuel Cells
- Hybridisation of Energy Sources
- Battery Faults
- Remaining Useful Life of Batteries
- Reuse of Retired EV Batteries
- Battery Charging Strategies
- Machine Learning in Battery Management

Fill in the student group and select the project via Google Excel Link:
https://docs.google.com/spreadsheets/d/1UBGuKWeS-IF0jtL0MoKL_WkYejF2ovTwYkoTO1ugh9k/edit?gid=0#gid=0

Quiz & Final Exam

In-Class Test

- The quiz (in-class test) is **face-to-face in the class.**
- It usually **covers the course materials right before the In-Class Test**.
- The quiz is **open-book** and **open-note**, and you are only allowed to refer to your own note, instructor's note, text/reference books, electronic notes, and the information in Blackboard. No other materials are allowed. No internet access to outside is allowed.

Final Exam

- It is **closed book**. You have to come **in person** to take the exam.

Coursework and Miniproject Report Submission

- ~~By Email~~: **DO NOT send by email** as it may not be received or go to spam.
- **By Blackboard**: Submission must be submitted electronically to the Blackboard.

Format of the file name

- For MiniProject report: **MiniPNo_StudentName.pdf** or **MiniPNo _StudentName.doc**
- For Homework: **AssNo_StudentName_StudentNo.pdf** or **AssNo_StudentName _StudentNo.doc**

Notes

- All homework submissions must be done individually and **no group submission**. For Miniproject report, **nominate one** of the group members to submit the report. The report must be written with **all members' names and student ID**. Your mark may be the same as your group member.
- The solution to the homework will be released after the marking, usually within 2-3 weeks.

The Subject Policies

Academic integrity, late policy, and illness

Academic Integrity

- Among these is turning in another's work as your own, committing plagiarism, which is the copying of portions of another's words from a published or electronic source without acknowledgement of that source and consulting solution keys not authorized by the instructor.
- The penalty for a breach of academic integrity is a double-zero (−100%) for the work in question on the first offense and a failing grade for the course as a whole with repeated offenses.
- Academic Integrity issues during the quiz (in-class test) and exam is needed to report to the Academic Secretary or Head of the Department.

Late Policy and Illness

Late Policy

- **Late on day due:** 10% penalty
- **One calendar day late:** 20% penalty
- **Two calendar days late:** 40% penalty

Illness

- If you are ill, especially with a fever, please **stay home and rest**.
- If it is during a quiz (in-class test) or exam, **doctor's note** is needed.
- Please **notify the instructor** via email if you are missing class due to illness.

The Subject Syllabus & Schedule

Syllabus & Schedule

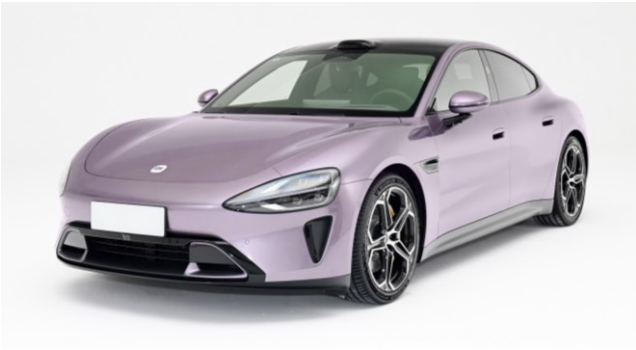
Week	Date	Descriptions	Lecturer	Assignment/ report/text
1	2 Sept	**LESSON 1: INTRODUCTION & CLASSIFICATION OF EV ENERGY SOURCES** - Miniproject announcement	**Liu**	
2	9 Sept	**LESSON 2: BATTERIES**	**Liu**	
3	16 Sept	**LESSON 3: SUPERCAPACITORS**	**Liu**	
4	23 Sept	**LESSON 4: ULTRAHIGH-SPEED FLYWHEELS**	**Liu**	Homework 1: due in 2 weeks
5	30 Sept	**LESSON 5: FUEL CELLS**	**Liu**	
6	7 Oct (Public holiday)	**LESSON 6: HYBRIDISATION OF ENERGY SOURCES** Oct 11, 9:30am – 12:20noon / 14:00 – 17:20pm	**Liu**	TBC
7	14 Oct	**LESSON 7: CASE STUDY**	**Liu**	**In-class test**
8	21 Oct	**LESSON 8: LITHIUM-ION BATTERIES AND BATTERY MANAGEMENT SYSTEMS**	**Tian**	
9	28 Oct	**LESSON 9: BATTERY MODELS**	**Tian**	Homework 2: due in 2 weeks
10	7 Nov	**LESSON 10: BATTERY STATE OF CHARGE**	**Tian**	

Syllabus & Schedule (Cont'd)

Week	Date	Descriptions	Lecturer	Assignment/ report/text
11	11 Nov	**LESSON 11: BATTERY STATE OF HEALTH**	**Tian**	
12	18 Nov	**LESSON 12: BATTERY IMPEDANCE AND ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY**	**Tian**	
13	25 Nov	**LESSON 13: NEW ENERGY FOR VEHICLES Summary and review**	**Tian**	**In-class test**
	1 Dec – 21 Dec	**FINAL EXAM**	**Liu, Tian**	**In-person Exam**

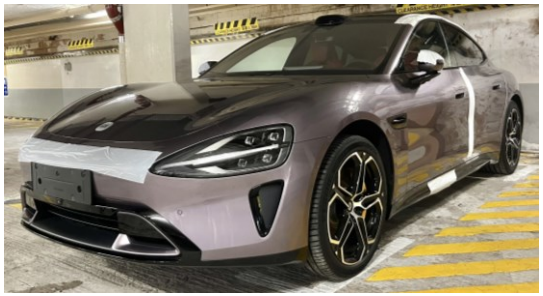
University-Industry Collaboration Platform

Xiaomi



Donation for collaboration

PolyU



Project Presentation List

Week	Date	Descriptions
1	2 Sept	No presentation
2	9 Sept	No presentation (allow students to have more time for preparation)
3	16 Sept	Topic 1: Start-of-the-Art Batteries for EVs
4	23 Sept	Topic 2: Supercapacitor Technology in EVs
5	30 Sept	Topic 3: Flywheels & Fuel Cells
6	7 Oct (Public holiday)	Topic 4: Hybridisation of Energy Sources Oct 11, 9:30am – 12:20noon / 14:00 – 17:20pm
7	14 Oct	Test – No Presentation
8	21 Oct	Topic 5: Battery faults
9	28 Oct	Topic 6: Remaining useful life of batteries
10	4 Nov	Topic 7: Reuse of retired EV batteries
11	11 Nov	Topic 8: Battery charging strategies
12	18 Nov	Topic 9: Machine learning in battery management
13	25 Nov	Test – No Presentation