

WM986-15 Energy Storage Systems

27/28

Department

WMG

Level

Taught Postgraduate Level

Module leader

Carlos Pastor Fernandez

Credit value

15

Module duration

4 weeks

Assessment

100% coursework

Study location

University of Warwick main campus, Coventry

Description

Introductory description

The transition to sustainable transportation has placed energy storage systems (ESS) at the forefront of innovation in the automotive industry. This module offers a comprehensive exploration of the technologies that power hybrid and electric vehicles (HEVs and EVs), with a particular focus on the design, integration, and performance of advanced battery systems. As global demand for cleaner mobility solutions accelerates, understanding the role of ESS in achieving energy efficiency, reducing emissions, and enhancing vehicle performance is more critical than ever.

This module includes 30 hours over 4 weeks consisting of interactive presentations, question and answer sessions and discussion, online sessions, videos, small group exercises and problem classes.

The module includes a significant practical element (~30%) where students gain hands-on experience in battery manufacturing, battery modeling and characterisation testing.

Module aims

The module provides a comprehensive study of energy storage systems for electric vehicle applications in the automotive industry, and the complexities and challenges of introducing these technologies in passenger vehicles. In addition, this module provides students the scientific knowledge inside batteries to understand the fundamental mechanisms for battery operation,

design and manufacturing.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Energy storage requirements for vehicle applications
- Storage technologies and metrics for comparison
- Battery fundamentals: key terminologies, lithium-ion battery components, functions, and operation principles.
- Electrochemical principles of batteries: thermodynamics, kinetics and mass transport.
- Energy storage materials: chemistry of cathode and anode active materials, electrolyte and separator
- The manufacturing processes of battery cells, including mixing, coating, calendaring, cell assembly and formation
- Modular battery packs and packaging
- Battery modeling and battery charging
- Battery management systems
- Battery diagnostics and end of life
- Hands-on practical: Battery modeling
- Hands-on practical: Battery characterisation and testing
- Hands-on practical: Battery cell design and manufacturing

Learning outcomes

By the end of the module, students should be able to:

- Demonstrate conceptual analysis of the electrochemical working principles of Li-ion batteries and evaluate different energy storage materials for battery cell design and manufacturing [AHEP:4; 7, M2]
- Independently make a systematic and sound choice of energy storage technologies, architecture and means of conversion for practical real-world vehicle applications [AHEP:4; 7, M2, M6]
- Independently design the electrical configuration of a traction energy storage pack, interpreting thermal management, energy management, safety and environmental considerations [AHEP:4; 7, M2, M3, M6]e guidelines, safety systems and practical considerations [AHEP:4; 7, M2, M3]
- Interpret battery characterisation, battery manufacturing or battery modelling practical activities in electric vehicles [AHEP:4; 7, M2]
- Work collaboratively in a team to resolve problems in the context of energy storage systems [AHEP:4; 7, M16]

Indicative reading list

[Reading lists can be found in Talis](#)

Subject specific skills

Energy storage requirements for vehicle applications; storage technologies and metrics for comparison; battery fundamentals; electrochemical principles of batteries; energy storage materials; manufacturing process of battery cells; modular battery packs and packaging; battery modeling and battery charging; battery management systems. Hands-on practical: battery modeling; battery characterisation and testing.; battery cell design and manufacturing.

Transferable skills

Critical thinking; Problem solving; Self-awareness; Communication; Teamwork and working effectively with others; Information literacy (research skills); Digital literacy; Sustainability; Professionalism; Organisational awareness.

Study

Study time

Type	Required
Lectures	16 sessions of 1 hour (11%)
Seminars	2 sessions of 1 hour (1%)
Supervised practical classes	12 sessions of 1 hour (8%)
Online learning (independent)	15 sessions of 1 hour (10%)
Private study	45 hours (30%)
Assessment	60 hours (40%)
Total	150 hours

Private study description

Online independent learning and private study learning includes:

- Preparation and revision of lectures after delivery
- Completion of activities related to energy storage systems.
- Prior research required to complete the assessment

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group A4

	Weighting	Study time	Eligible for self-certification
Assessment component			
Evaluation of technology application	70%	42 hours	Yes (extension)
This part is related to discussing a typical energy storage design based on given requirements.			
Reassessment component			
Evaluation of technology application			No
This part is related to discussing a typical energy storage design based on given requirements.			
Assessment component			
Evaluation of practical activities - Group work	30%	18 hours	No
This is a group task and consists in recording a video presentation of one of the practicals undertaken in the module. The group chooses which practical to report.			
Reassessment component			
Evaluation of practical activities - Individual work			No
The student needs to record a video presentation based on the practical activities undertaken in the module.			

Feedback on assessment

Feedback is provided following on from University/Department current policies. The written feedback will be provided based on WMG feedback template and it will address each of the questions submitted.

Availability

There is currently no information about the courses for which this module is core or optional.