ES96X-15 Batteries and Fuel Cells

23/24

Department
School of Engineering
Level
Taught Postgraduate Level
Module leader
Shanwen Tao
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES96X-15 Batteries and Fuel Cells

Module web page

Module aims

To introduce students to the principles of modern energy storage and fuel cells and their applications, including grid-scale storage, vehicle propulsion and portable electronics. The module will provide students with a firm grounding in the thermodynamic principles of electrochemical, electrical and mechanical energy conversion with a focus on fuel cells and energy storage methods, e.g., batteries, supercapacitors and pumped hydro.

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.

- Types of electrochemical cells for energy conversion
- Principle of batteries and types of batteries (energy storage)
- Principles of a fuel cell and types of fuel cell (energy generation)

- Quantitative characterisation of fuel cell performance: voltage losses and their management
- Applications of fuel cells in different sectors
- Challenges in development (degradation, materials, costs, engineering)
- Advanced and emerging battery systems (Li-air, secondary metal-air, flow, molten-salt) and applications areas
- Quantitative characterisation of battery performance: voltage losses and their management
- Energy storage systems and methods: electrochemical, thermal, flywheel, pumped hydro, hydrogen storage, supercapacitors, superconducting magnet and electrochemical
- Integrated systems and calculations of energy efficiency and figures of merit for performance

Learning outcomes

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

- Autonomously apply the principles governing the operation of advanced battery and fuel cell systems to solve complex problems. [M1, M2]
- Independently perform systematic and detailed calculations to evaluate figures of merit, such as efficiency and power. [M1, M2]
- Critique the effectiveness of mechanical and thermal energy storage systems in various applications and illustrating technology limitations. [M13]
- Critique the material requirements for current and future fuel cell and energy storage technologies, and show a sound understanding of the main degradation mechanisms. [M6, M13]
- Critically evaluate the components, operation, and limitations of advanced, state-of-the-art energy storage systems such as flow batteries, supercapacitors, and flywheels. [M4, M6, M13]
- Evaluate the existing, and hypothesize the future requirements of energy storage and fuel cell applications. [M4, M13]
- Evaluate specifications and demonstrate an autonomous ability to select and size appropriate energy storage technologies. [M6, M13]

Indicative reading list

1. Revankar, W.T., fuel Cells: Principles, Design, and Analysis. 2016.
2. X. Li, Principles of Fuel Cells, Taylor and Francis, 2006.
3. R. Huggins, Energy Storage, Springer, 2010.
4. Daniel. C. Harris, Quantitative Chemical Analysis, Freeman, 2007
5. James Larminie and Andrew Dicks, Fuel Cell Systems Explained (2nd Ed) Wiley, 2003.
6. Robert A. Huggins, Energy Storage, Springer, 2016.
7. Christian Julien, Alain Mauger, Ashok Vijh and Karim Zaghib, Lithium batteries : science and technology, 2016.

Subject specific skills

Good knowledge in basic electrochemistry;
Based on the knowledge in basic electrochemistry, have deep understanding on the principles and operating mechanism of fuel cells and batteries;
Based on the knowledge in fuel cells and batteries, have better understanding on their applications in renewable energy storage, electric vehicles.

Transferable skills

The skills and knowledge learned in this course can be applied in future jobs in the section of renewable energy storage and electric vehicles.

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (18%)
Seminars	2 sessions of 1 hour (1%)
Other activity	2 hours (1%)
Private study	116 hours (68%)
Assessment	20 hours (12%)
Total	170 hours

Private study description

Guided independent learning 116 Hours

Other activity description

Example classes

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B6

	Weighting	Study time
Online Examination	100%	20 hours
2 Hr QMP		
~Platforms - AEP,QMP		

- Online examination: No Answerbook required

Feedback on assessment

A documents on feedback on the multi-choice assessment will be provided.

Past exam papers for ES96X

Availability

Courses

This module is Core for:

- Year 4 of UESA-H311 MEng Mechanical Engineering
- Year 1 of TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies

This module is Core optional for:

- Year 2 of TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies

This module is Optional for:

- Year 4 of UESA-H116 MEng Engineering with Exchange Year
- Year 5 of UESA-H115 MEng Engineering with Intercalated Year
- Year 1 of RESA-H6P9 Postgraduate Research Wide Bandgap Power Electronics

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering
- Year 4 of UESA-H316 MEng Mechanical Engineering
- Year 4 of UESA-H318 MEng Mechanical Engineering with Exchange Year
- Year 5 of UESA-H317 MEng Mechanical Engineering with Intercalated Year
- Year 1 of TESA-H643 Postgraduate Taught Electrical Power Engineering
- Year 1 of TESA-H642 Postgraduate Taught Energy and Power Engineering

This module is Option list B for:

- Year 4 of UESA-H311 MEng Mechanical Engineering

This module is Option list C for:

- UESA-H311 MEng Mechanical Engineering
  - Year 4 of H30G Mechanical Engineering with Business Management
  - Year 4 of H30P Mechanical Engineering with Fluid Dynamics