

# WM990-15 Automotive Powertrain Electrification Fundamentals

**22/23**

**Department**

WMG

**Level**

Taught Postgraduate Level

**Module leader**

Andy Gardiner

**Credit value**

15

**Module duration**

2 weeks

**Assessment**

100% coursework

**Study locations**

University of Warwick main campus, Coventry Primary

Distance or Online Delivery

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## Description

### Introductory description

The 21st century automotive industry is transitioning at pace to electric propulsion technology, presenting new challenges in component and system design and vehicle integration. This module provides a holistic introduction to electrified automotive powertrains, from global motivations through to component design. Existing approaches to partial and full electrification are critiqued and opportunities for new design and research opportunities are exposed. The module is delivered through a mix of traditional lectures, group discussion and design activities and hands-on practicals using both established and novel tools and techniques.

### Module aims

To equip participants to constructively engage with automotive powertrain electrification programmes and technologies in their current or future engineering careers.

### 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.

Motivations for the transition to electrified powertrains in automotive applications.

Emissions formation and control.

Air quality and global warming.

Life cycle analysis of environmental impact.

Industry roadmaps for low carbon vehicle technology.

Assessment of vehicles against certification requirements.

Hybrid and pure electric powertrain architectures.

Vehicle product case studies.

Road load modelling and systematic energy and power requirements derivation.

Energy storage technologies.

Battery modularity and design.

Electrical behaviour and modelling of batteries.

Charging processes and the impact on user experience and carbon footprint.

Electric machine types and approaches to torque control.

Drivetrain and battery specification and matching to vehicle system requirements.

On-board energy management and optimisation.

## **Learning outcomes**

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

- Independently critique global stakeholder influences, motivations and industry progress in automotive powertrain electrification.
- Comprehensively understand existing H/EV products, their relative merits and critique designs against practical real-world applications.
- Systematically derive power and energy requirements for automotive products in alignment with standardised evaluation criteria and real-world end-user requirements.
- Design and evaluate energy storage and electric machine technology as co-dependant sub-systems of vehicle powertrain applications.
- Critique a wide variety of approaches to energy management with regards to applicability, complexity, optimality, resource requirements and practicality.

## **Indicative reading list**

Propulsion Systems for Hybrid Vehicles - John M. Miller

Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Third Edition: International Student Edition - Mehrdad Ehsani Yimin Gao Stefano Longo Kambiz Ebrahimi &

Electric and Hybrid Vehicles - Tom Denton

Hybrid Electric Vehicles: Energy Management Strategies (Springer Briefs in Electrical and Computer Engineering) - Simona Onori Lorenzo Serrao Giorgio Rizzoni &

Principles of Electric Machines and Power Electronics, 3rd Edition

Battery Systems Engineering | Wiley

[View reading list on Talis Aspire](#)

## Subject specific skills

Ability to independently critique global stakeholder influences, motivations and industry progress in automotive powertrain electrification.

Comprehensive understanding of existing H/EV products, their relative merits and the ability to critique designs against practical real-world applications.

Ability to systematically derive power and energy requirements for automotive products in alignment with standardised evaluation criteria and real-world end-user requirements.

Ability to design and evaluate energy storage and electric machine technology as co-dependant sub-systems of vehicle powertrain applications.

Ability to critique a wide variety of approaches to energy management with regards to applicability, complexity, optimality, resource requirements and practicality.

## Transferable skills

Critical thinking, Problem solving, Information literacy (research skills), Sustainability, Ethical values, Professionalism

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## Study

### Study time

Type	Required
Lectures	13 sessions of 1 hour 30 minutes (13%)
Seminars	5 sessions of 1 hour 30 minutes (5%)
Supervised practical classes	5 sessions of 1 hour 30 minutes (5%)
Online learning (independent)	25 sessions of 1 hour (17%)
Other activity	2 hours 30 minutes (1%)
Assessment	84 hours (58%)
Total	146 hours

### Private study description

No private study requirements defined for this module.

### Other activity description

30 minutes daily reflection (tutor led)

## Costs

No further costs have been identified for this module.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group A1

	Weighting	Study time
Online discussion forum	15%	2 hours
Tutor assessment of contribution to online discussion forum linked to pre-module individual study.		
In Module Online Test	15%	2 hours
End of taught week online multi-choice / short answer test. Questions chosen randomly from bank. 2 hrs prep time in class with tutor for Q&A / discussion. 60 minutes to complete assessment live online.		
Post-module Design Assignment	50%	60 hours
Written assignment to make justified design decisions against a requirements brief.		
Critical review of academic research paper	20%	20 hours
Students directed to one or more published papers and submit a written critical review of the same.		

### Feedback on assessment

Individual written feedback and graded mark for discussion forum contribution and two written pieces.

Individual correct / incorrect and total score for online test submission.

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## Availability

## Courses

This module is Core optional for:

- Engineering Competence (Smart, Connected and Autonomous Vehicles)