# ES4B7-15 Vehicle Propulsion

## 22/23

**Department**
School of Engineering
**Level**
Undergraduate Level 4
**Module leader**
Emma Rushforth
**Credit value**
15
**Module duration**
10 weeks
**Assessment**
40% coursework, 60% exam
**Study location**
University of Warwick main campus, Coventry

---

## Description

### Introductory description

ES4B7-15 Vehicle Propulsion

Module web page

### Module aims

At the end of this module students will be able to critically analyse a range of common propulsion technologies such as ICE, electrification and hybrid solutions.

### 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.

Propulsion choices.
Motivation for using HEVs
Preliminary concepts: Thermodynamic processes
Engine power cycles
Ignition and valve timing
Combustion fundamentals in SI and CI engines

Actual fuel-air cycles: Otto, diesel and two-stroke
Mixture preparation: stoichiometric, rich and lean mixtures
Combustion and exhaust formation
Emission norms, testing and control
Engine force balance and performance characteristics
Engine performance testing and turbocharging
Vehicle transmission
Vehicle power and traction requirements calculation
Engine sizing for HEV application
Hybrid vehicle architecture
Electric Machines: Principles and Modelling
Design of PM synchronous motors
Switched reluctance (stepper) and induction motors
Control of permanent magnet, stepper and induction motors
Energy storage technologies: electrical and mechanical
Battery modelling and characterisation
Battery pack design, management and control systems
Fuel cells

## Learning outcomes

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

- Be familiar with the design and operating parameters and internal-combustion engine operating characteristics.
- Interpret the requirements for and operating characteristics of HEV enabling technology and the complexity of technology integration.
- Critically analyse the diverse justifications for vehicle hybridisation and electrification.

## Indicative reading list

Borgnakke, C. and Sonntag, R.E., 2019, Fundamentals of Thermodynamics, 10th edition, Wiley.
Yunus C. and Michael B., 2019, Thermodynamics: An Engineering Approach, 9th edition, McGraw Hill.
Heywood, J.B., 2018, Internal Combustion Engine Fundamentals 2E, 2nd edition, McGraw Hill.
Ganesan, V., 2013, Internal Combustion Engines, 4th edition, Tata McGraw Hill.
Stone, R., 2012, Introduction to Internal Combustion Engines, 4th edition, Macmillan.
Mi C., Masrur MA., 2017, Hybrid electric vehicles: principles and applications with practical perspectives, 2nd edition, Wiley.
J Miller, 2010, Propulsion Systems for Hybrid Vehicles, IET.
A Emadi, 2014, Advanced Electric Drive Vehicles, 1st edition, CRC Press.

## Subject specific skills

Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality.
Ability to develop economically viable and ethically sound sustainable solutions

### Transferable skills

Appreciation of the global dimensions of engineering, commerce and communication
Be professional in their outlook, be capable of team working, be effective communicators, and be able to exercise responsibility and sound management approaches.
Exercise initiative and personal responsibility, including time management, which may be as a team member or leader.
Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions.
Plan self-learning and improve performance, as the foundation for lifelong learning/CPD

---

## Study

## Study time

| Type | Required |
|---|---|
| Seminars | 18 sessions of 2 hours (24%) |
| Other activity | 2 hours (1%) |
| Private study | 112 hours (75%) |
| Total | 150 hours |

### Private study description

Guided Independent Learning 112 hours

### Other activity description

Examples class (exam revision)

## Costs

No further costs have been identified for this module.

---

## Assessment

You must pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

### Assessment group D3

| | Weighting | Study time |
|---|---|---|
| Individual report<br>8 pages/1600 words | 40% | |
| Online Examination<br>TYPE TBD<br><br>~Platforms - QMP | 60% | |

---

- Online examination: No Answerbook required
- Engineering Data Book 8th Edition

### Feedback on assessment

Individual and cohort feedback for all assessments.

Past exam papers for ES4B7

---

## Availability

## Courses

This module is Core for:

- Year 4 of UESA-H336 MEng Automotive Engineering

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

This module is Option list A for:

- Year 5 of UESA-H337 MEng Automotive Engineering with Intercalated Year
- Year 4 of UESA-H114 MEng Engineering
- Year 4 of UESA-HH76 MEng Manufacturing and Mechanical Engineering
- Year 5 of UESA-HH38 MEng Manufacturing and Mechanical Engineering with Intercalated Year
- Year 5 of UESA-HH77 MEng Manufacturing and Mechanical Engineering with Intercalated Year
- Year 4 of UESA-H311 MEng Mechanical Engineering

This module is Option list B for:

- UESA-H311 MEng Mechanical Engineering
    - Year 4 of H311 Mechanical Engineering
    - Year 4 of H30L Mechanical Engineering with Automotive Engineering
    - Year 4 of H30G Mechanical Engineering with Business Management
    - Year 4 of H30P Mechanical Engineering with Fluid Dynamics
    - Year 4 of H30H Mechanical Engineering with Sustainability
- Year 4 of UESA-H318 MEng Mechanical Engineering with Exchange Year
- Year 5 of UESA-H317 MEng Mechanical Engineering with Intercalated Year

This module is Option list C for:

- UESA-H311 MEng Mechanical Engineering
    - Year 4 of H30J Mechanical Engineering with Appropriate Technology
    - Year 4 of H30M Mechanical Engineering with Robotics
    - Year 4 of H30N Mechanical Engineering with Systems Engineering