WM982-15 Power electronic converter design and manufacturing

20/21

Department
WMG
Level
Taught Postgraduate Level
Module leader
Borislav Dimitrov
Credit value
15
Module duration
1 week
Assessment
100% coursework
Study locations
University of Warwick main campus, Coventry Primary
Distance or Online Delivery

Description

Introductory description

This module provides in-depth knowledge of power electronic devices and converter topologies for hybrid and electric vehicles. It includes the integration, reliability and manufacturing of power electronic converters. Advanced PWM control methods and electromagnetic compatibility are introduced. This module covers modelling and design of power converters in detail through lectures, workshops and practical. It also introduces future power electronics technologies for the upcoming EV applications.

Module aims

This module aims to:
Extend students' depth of knowledge of power electronic circuits and components for hybrid and electric vehicles.
Introduce integration, reliability and manufacturing considerations of power electronic converters.
Introduce thermal modelling and cooling design of power electronic converters.
Provide students with skills and techniques necessary for analysis, modelling and design of power electronics and related control systems for automotive applications.

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.

Power electronics in automotive applications overview
Power semiconductor devices
Manufacturing, life time and reliability of power electronic converters
DC/DC converters (Buck/Boost)
Isolated DC/DC converters
AC/DC converters, rectifier and PFC circuit
DC-AC inverters
Advanced PWM control methods
Battery charging and Wireless charging circuits
Electromagnetic compatibility, integration and thermal management of power converter
Power converter modelling and design
Power converter design workshop
Power converter testing practical
Future technology direction: state-of-art power semiconductor devices and converter technologies for hybrid and electric vehicles

Learning outcomes

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

- Critically evaluate characteristics of power semiconductor devices and select devices for a range of automotive applications.
- Differentiate power converter topologies, operation, control and practicalities for real-world application to hybrid and electric vehicles.
- Evaluate detailed operation, losses and efficiency of power electronics converters through use of analytical methods and modelling techniques.
- Interpret the integration, reliability and manufacturing of power electronic components for automotive applications.
- Systematically design power electronic subsystem/ system for hybrid and electric vehicles and critique design trade-offs and technology advances.

Indicative reading list

1. Mohan N "Power Electronics - Converters Applications & Design" Wiley
2. Rashid, Muhammad H. "Power electronics : devices, circuits, and applications " Pearson; 4 edition 2014
3. Kassakian, J.G "Principles of Power Electronics" Addison-Wesley 1991
4. John G. Hayes, G. Abas Goodarzi "Electric powertrain : energy systems, power electronics & drives for hybrid, electric and fuel cell vehicles" John Wiley & Sons 2018

Subject specific skills

Ability to applying and developing analytical techniques for design of power converters.
Ability to simulate and design power converters using commercial software.
Ability to evaluate the limitations of design software and choose appropriate methods and tools for designing power converters.
Ability to propose design concepts and principles relating to the development of power converters, services and specifications
Ability to interpret integration challenges, EMC, cooling concepts including material applications and systems methodology as applicable.
Ability to identify diagnostic methods, monitoring and test equipment required for integration of power converters for EV and hybrid vehicles.
Ability to interpret the packaging and manufacturing of power electronic converters for automotive applications.

Transferable skills

Practical competence to deliver innovative products and services
Ability to Interpret and analyse test results.
Ability to work with manufacturing specialists to ensure design can translate to manufacturing processes and system
A comprehensive understanding of the relevant scientific principles of electrical machines
A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of the specialisation.
Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations.
Ability to use fundamental knowledge to investigate new and emerging technologies.
Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.

Study

Study time

Type	Required
Lectures	12 sessions of 1 hour 30 minutes (12%)
Seminars	2 sessions of 1 hour 30 minutes (2%)
Tutorials	1 session of 2 hours (1%)
Practical classes	1 session of 8 hours (5%)
Supervised practical classes	2 sessions of 4 hours 30 minutes (6%)
Online learning (scheduled sessions)	4 sessions of 1 hour (3%)
Online learning (independent)	4 sessions of 6 hours (16%)
Assessment	82 hours (55%)
Total	150 hours

Private study description

No private study requirements defined for this module.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group A

	Weighting	Study time
Post Module Assessment report	70%	70 hours
The first part of the PMA summarises the converter testing practical and includes critical discussion of test observations. The second part of the PMA is design proposal of a power conversion system for an EV application and critiques of electrical, mechanical, thermal design aspects as well as reliability and manufacturing considerations.		
Power semiconductor characteristics worksheet	10%	2 hours
After the online pre-learning, students will submit worksheets to answer multiple choice questions and evaluate characteristics of power semiconductor devices including diode, thyristor, BJT, MOSFET and IGBT.		
Video presentation on power converter design	20%	10 hours
The students will submit a video to present loss calculation and thermal simulation of their converter design from the design workshop. They will also discuss integration challenges and cost considerations of their design.		

Feedback on assessment

The semiconductor characteristics worksheets will be marked and returned to students 4 weeks before the PMA deadline so that the feedback will help students with their PMA.

The video presentation will be marked with an assessment report which will be returned to students 3 weeks before the PMA deadline.

The PMA will be marked based on comprehension, effort and presentation.
An overall mark of the module is sent to students with the PMA assessment report.

Availability

Courses

This module is Core optional for:

- MSc in Sustainable Automotive Electrification (PT) [New Course]

This module is Core option list A for:

- Engineering Competence (Sustainable Automotive Electrification) [New Course]
- MSc in Sustainable Automotive Electrification (FT) [New Course]