WM982-15 Power electronic converter design and manufacturing

24/25

Department
WMG
Level
Taught Postgraduate Level
Module leader
Borislav Dimitrov
Credit value
15
Module duration
4 weeks
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 demonstrations – converter or inverter characterisation.
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 [AHEP:4; 7, M4]
- Differentiate power converter topologies, operation, control and practicalities for real-world application to hybrid and electric vehicles [AHEP:4; 7, M4]
- Evaluate detailed operation, losses and efficiency of power electronics converters through use of analytical methods and modelling techniques [AHEP:4; 7, M4]
- Interpret the integration, reliability and manufacturing of power electronic components for automotive applications [AHEP:4; 7, M4]
- Systematically design power electronic subsystem/ system for hybrid and electric vehicles and critique design trade-offs and technology advances [AHEP:4; 7, M4]

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

View reading list on Talis Aspire

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	18 sessions of 1 hour (12%)
Seminars	12 sessions of 1 hour (8%)
Tutorials	(0%)
Online learning (scheduled sessions)	(0%)
Online learning (independent)	18 sessions of 1 hour (12%)
Private study	42 hours (28%)
Total	150 hours

Type	Required
Assessment	60 hours (40%)
Total	150 hours

Private study description

During the module delivery, the students are expected to learn the Power Electronics theory independently, following the materials presented in the lectures and seminars. This includes the central topics of power converters and inverters design and manufacturing. The students will use the provided design application notes and datasheets to study additional topics like power factor correction, electromagnetic compatibility, assembly, and thermal management. Also, working independently, the students will be expected to conduct modelling and simulations using freeware software products to obtain results for their courseworks.

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 A3

	Weighting	Study time	Eligible for self-certification
Assessment component			
Coursework: Automotive Traction Inverter Design and Analysis	80%	48 hours	Yes (extension)

The Coursework is focused on the design of a high-voltage, high-power traction inverter for electric vehicles. The project includes the primary inverter power circuits and networks analysis and design as follows: second level three-phase power inverter; gate drivers; voltage and current sense networks; auxiliary power supplies. The main focus is given on losses calculation, efficiency estimation, thermal analysis, assembling procedure and reliability estimation.

Reassessment component is the same

Assessment component

	Weighting	Study time	Eligible for self-certification
Video presentation on power converter design (IMA)	20%	12 hours	No

The Coursework is focused on the design of a low-voltage converter for hybrid electric vehicles. The project includes the design of primary circuits as follows: main switches selection for the power stage; gate drivers; measurement networks and protections; filters and operational amplifiers. The main focus is given on losses calculation, efficiency estimation and thermal analysis.

Reassessment component is the same

Feedback on assessment

Written feedback for both assessments will be provided.
The feedback will provide details on the current work assessment and suggestions for future improvements applicable to students' future industrial projects.

Availability

Pre-requisites

To take this module, you must have passed:

- All of
  - WM994-15 Electrical Drivetrains

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