ES4D4-15 Power Electronic Converters & Devices

26/27

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

Description

Introductory description

ES4D4-15 Power Electronic Converters & Devices

Practically all electronic equipment, whether domestic or industrial, requires power conditioning to deliver the energy for it to operate correctly. This is using electronics for power processing, not information processing. The applications vary widely from power supplies for laptops and mobile phone chargers, through industrial motor drives, hybrid and electric vehicle drives, electric rail transport, to solar and wind energy systems and power transmission and distribution systems.

Module web page

Module aims

The module aims are:

- To introduce the concept of power electronics as power processing and control, and to present the range of applications of power electronics in today’s society.
- To introduce power semiconductor devices as basic switching elements used in power

electronic converters, and describe the theory of their operation.
- To introduce power electronic converters, explain their operation principles and give examples of applications.
- To develop an understanding of the issues present in converter and device design, including the impact of physical layout and heat dissipation.
- To understand the basics of DC motor drives and control

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.

- Introduction to power electronics, devices and applications.
- Semiconductor theory: revision and in depth discussion. Band theory, doping, p-n junctions. Avalanche breakdown and punchthrough. Carrier lifetime and the effect on resistance and switching speeds.
- Power semiconductor device physics: PiN and Schottky diodes, thyristors, bipolar transistors, MOSFETs, IGBTs.
- An introduction to wide bandgap semiconductors and devices. An insight into silicon carbide; specifically, its advantages and potential (high voltage, high frequency and high temperature devices) and its problems (cost, immaturity, processing issues).
- Power semiconductor device fabrication.
- Power converters: single and three phase AC-DC converters, buck, boost and buck-boost DC-DC converters, isolated converters, bridge DC-DC converter and DC-AC inverters, resonant converters.
- Non-ideal case analysis: commutation and overlap, introduction of power quality and filters.
- Design and simulation of devices.
- Applications: solar power, distributed generation, wind power, hybrid & electric vehicles.
- `An introduction to DC motor drives and control`

Learning outcomes

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

- Advanced knowledge in the field of operation of power semiconductor devices. Apply mathematical models in the field of power semiconductor devices. M1
- Advance mathematical models to software simulation of operation of power semiconductor devices. M3
- Design and analyse a power converter, including an AC-DC converter, a DC-DC converter and a DCAC inverter. M1, M2
- Analyse the power quality and harmonics. Design the basic filters to smooth the converter output and to improve the power quality. M6
- With the aid of literature, explain the practical issues in converter design. M4, M12
- Evaluate the applications of power electronics and the development of new devices. M1,M4
- Design and test a boost DC-DC converter and its associated control M3, M4, M12, M13
- Demonstrate systems knowledge in DC motor drives and control analysis. M6

Indicative reading list

Reading lists can be found in Talis

Research element

- New development in power electronic device and converter design.
- Using research project and research outcome as examples in the teaching to show how research drives the technology progress.

Subject specific skills

- Power electronic device and their materials, formation, packaging, protection
- Power device selections and quantity analysis
- Power electronic converter design and circuit analysis
- Practical skills in device modelling and simulation, analysis for parameter optimisation
- Practical skills in converter parameter tuning
- Converter dynamic modelling and transition analysis
- Filter design for power quality improvement
- DC motor modelling and control

Transferable skills

- Practical skills in electronic equipment usage
- Lab results analysis
- Computer simulation using PSPICE software

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Practical classes	12 sessions of 1 hour (8%)
Other activity	6 hours (4%)
Private study	102 hours (68%)
Total	150 hours

Private study description

Guided Independent Learning 102 hours

Other activity description

4 X 1 hour Example Classes
2 X 1 hour Revision Classes

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 BA

	Weighting	Study time	Eligible for self-certification
Assessment component			
Centrally-timetabled examination (On-campus) Standard written examination.	100%		No

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- Answerbook Pink (12 page)
- Engineering Data Book 8th Edition
- Students may use a calculator
- Graph paper

Reassessment component is the same

Feedback on assessment

Solutions to questions in problem sheets and discussion of the solutions during example classes. Cohort level feedback on examinations.

Past exam papers for ES4D4

Availability

Pre-requisites

To take this module, you must have passed:

- All of
  - ES2C0-15 Analogue Electronic Design

Post-requisite modules

If you pass this module, you can take:

- ES4E8-15 Advanced Power Electronic Converters and Devices

Courses

This module is Core for:

- Year 1 of RESA-H6P9 Postgraduate Research Wide Bandgap Power Electronics

This module is Core optional for:

- Year 2 of RESA-H6P9 Postgraduate Research Wide Bandgap Power Electronics
- Year 1 of TESA-H643 Postgraduate Taught Electrical Power Engineering
- Year 1 of TESA-H642 Postgraduate Taught Energy and Power 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
- Year 2 of TESA-H1A0 Postgraduate Taught Sustainable Energy Technologies

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering
- Year 4 of UESA-H311 MEng Mechanical Engineering

This module is Option list B for:

- Year 4 of UESA-HH31 MEng Systems Engineering
- Year 4 of UESA-HH33 MEng Systems Engineering with Exchange Year
- Year 5 of UESA-HH32 MEng Systems Engineering with Intercalated Year
- Year 1 of TESA-H644 Postgraduate Taught Electrical and Electronic Engineering