

# ES4F2-15 Control of Electrical Drives

**24/25**

**Department**

School of Engineering

**Level**

Undergraduate Level 4

**Module leader**

Oleh Kiselychnyk

**Credit value**

15

**Module duration**

10 weeks

**Assessment**

40% coursework, 60% exam

**Study location**

University of Warwick main campus, Coventry

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## Description

### Introductory description

ES4F2-15 Control of Electrical Drives

[Module web page](#)

### Module aims

Modern electrical drives are complex electromechanical systems combining electrical machines, power electronic converters, control and protection circuits. The aim of the module is to develop an advanced understanding and systematic analysis and design skills on integration of electrical machines and power electronics into up-to-date electrical drives with predefined and required control quality. It will include development of conceptual functional block diagrams of the electrical drives, their mathematical modelling and simulation, systematic design of required controllers, advanced analysis of steady state and dynamic drives' characteristics, electrical schematics and modern practical implementation.

### 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.

1. Mechanics of electrical drives
2. Steady state and transient characteristics of separately excited DC motors for different control approaches
3. Soft start and velocity open loop control of separately excited DC motors
4. Fundamentals of closed loop control of electrical drives
5. Closed loop velocity control of separately excited DC motors
6. Angular velocity and position sensors
7. Closed loop velocity control of separately excited DC motors with current limitation
8. Two loop cascade velocity control of separately excited DC motors
9. Current feedback circuitries and EMF sensors
10. Two zone cascade control of the velocity of the separately excited DC motors with field weakening
11. Control of DC motors with summing amplifier structure
12. Torque control of separately excited DC motors
13. Position control of separately excited DC motors
14. Steady state mechanical characteristics of induction machines. Derivation
15. Steady state mechanical characteristics of induction machines for different control approaches
16. Basics of two-phase dynamic model of induction motors with short-circuited rotor
17. Two phase dynamic model of induction motors with short-circuited rotor in an arbitrary rotated reference frame and in the stationary stator reference frame
18. Power converters for induction motor drives
19. Open loop velocity control of induction motors
20. Closed loop scalar velocity control of induction motors
21. Vector control of induction motors
22. Induction motor control via voltage regulation
23. Control of wound rotor induction motors from the rotor side
24. Modelling of permanent magnet synchronous motors and vector control
25. Zero d-axis, maximum torque per ampere and maximum efficiency control approaches for permanent magnet synchronous motors

## Learning outcomes

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

- Advanced understanding and design of DC electrical drive control systems [M1, M2, M3, M4, M6]
- Advanced understanding and design of AC electrical drive control systems [M1, M2, M3, M4, M6]
- Systematic simulation of electrical drive control systems [M1, M2, M3, M4]
- Experimental testing of modern industrial complex electrical drive control systems [M4, M6, M12]

## Indicative reading list

1. N.P. Quang, J.-A. Dittrich, Vector control of three-phase AC machines : system development

- in the practice, 2nd edition, Springer, 2015.
2. R. Krishnan, Permanent magnet synchronous and brushless DC motor drives, CRC Press/Taylor & Francis, 2010.
  3. P. Krause, O. Wasynczuk, S. Sudhoff, S. Pekarek, Analysis of electric machinery and drive systems, 3rd edition, Wiley, 2013.
  4. W. Leonhard, Control of Electrical Drives, 3-rd ed., Springer, 2001.

### **Subject specific skills**

1. Ability to conceive, make and realise a component, product, system or process.
2. Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality.
3. Ability to seek to achieve sustainable solutions to problems and have strategies for being creative and innovative.

### **Transferable skills**

1. Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions.
  2. Apply problem solving skills, information retrieval, and the effective use of general IT facilities.
  3. Communicate (written and oral; to technical and non-technical audiences) and work with others.
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## **Study**

### **Study time**

<b>Type</b>	<b>Required</b>
Lectures	22 sessions of 1 hour (15%)
Tutorials	2 sessions of 1 hour (1%)
Practical classes	1 session of 4 hours (3%)
Other activity	2 hours (1%)
Private study	120 hours (80%)
Total	150 hours

### **Private study description**

Guided independent learning.

### **Other activity description**

Revision classes

## 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 D3

	<b>Weighting</b>	<b>Study time</b>
Laboratory Report A 2,000 word laboratory report on simulation and experimental testing of electrical drive control systems	40%	
Online Examination QMP online examination ~Platforms - AEP,QMP	60%	

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- Online examination: No Answerbook required
- Students may use a calculator
- Engineering Data Book 8th Edition

### Feedback on assessment

Support through advice and feedback hours.  
Written feedback on marked laboratory reports.  
Cohort-level feedback on final exam.

[Past exam papers for ES4F2](#)

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## Availability

### Courses

This module is Core for:

- Year 1 of TESA-H643 Postgraduate Taught Electrical Power Engineering
- Year 4 of UESA-H606 Undergraduate Electrical and Electronic Engineering MEng

- Year 5 of UESA-H607 Undergraduate Electrical and Electronic Engineering with Intercalated Year

This module is Optional for:

- UESA-H107 MEng Engineering
  - Year 4 of H107 Engineering MEng
  - Year 4 of H10E Engineering with Appropriate Technology MEng
  - Year 4 of H10J Engineering with Automotive Engineering MEng
  - Year 4 of H10C Engineering with Business Management MEng
  - Year 4 of H10G Engineering with Communications MEng
  - Year 4 of H10H Engineering with Computer Engineering MEng
  - Year 4 of H10M Engineering with Fluid Dynamics MEng
  - Year 4 of H10F Engineering with Instrumentation MEng
  - Year 4 of H10K Engineering with Robotics MEng
  - Year 4 of H10D Engineering with Sustainability MEng
  - Year 4 of H10L Engineering with Systems Engineering MEng
- Year 4 of UESA-H114 MEng Engineering
- Year 5 of UESA-H115 MEng Engineering with Intercalated Year