ES4F2-15 Control of Electrical Drives

20/21

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

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
- Advanced understanding and design of AC electrical drive control systems
- Systematic simulation of electrical drive control systems
- Experimental testing of modern industrial complex electrical drive control systems

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.

Study

Study time

Type	Required
Lectures	22 sessions of 1 hour (15%)
Tutorials	2 sessions of 1 hour (1%)
Practical classes	2 sessions of 3 hours (4%)
Other activity	2 hours (1%)
Private study	118 hours (79%)
Total	150 hours

Private study description

Guided independent learning.

Other activity description

Revision classes

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time
Laboratory Report 1	20%	
A 1,500 word laboratory report on simulation of electrical drive control systems		
Laboratory Report 2	20%	
A 1,500 word laboratory report on experimental testing of electrcial drive control systems		
Online Examination	60%	
QMP		

- 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]

Availability

Courses

This module is Core 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
- Year 4 of UESA-H606 Undergraduate Electrical and Electronic Engineering MEng

This module is Core optional for:

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

This module is Option list A for:

- Year 4 of UESA-H114 MEng Engineering