Engineering Tripos Part IIA, 3B4: Electric Drive Systems, 2017-18

Module Leader

Dr T Flack [1]

Lecturers

Dr P Long and Dr T Flack

Lab Leader

Dr P Long

Timing and Structure

Lent term. 16 lectures.

Aims

The aims of the course are to:

- Build on the Electrical Power Course given in Part 1B.
- Recognise that electrical motor drives in applications of all kinds are required to perform at high efficiency, controllability and reliability.
- Give an emphasis to design and applications of electical motor drives in housefold use, industry, and high performance machines.
- Look at general household use, typified by single phase motors.
- Examine three phase motors which are heavily utilised in industry for applications such as trains, pumps and conveyor belts.
- Look at high precision machines such as salient pole motors which are used at the small end of mechatronics and pernament magnet motors which are high performance machines also of use in mechatronics.
- Explore the overall design of mechatronic devices such as robots.

Objectives

As specific objectives, by the end of the course students should be able to:

- Understand the basic principles of operation.
- Be able to apply simple motor design rules.
- Be able to specify diffferent motors for different applications.
- Understand the design contstriants on multiple motor machines.
- Appreciate magnetic and thermal constraints.
- Be aware of different magnet materials and suitability for motor operation.

Content

Motor Design (4 lectures)

Basic ac winding design, specific magnetic and electric loadings, air gap volume, magnetic circuit design, saturation effects. Thermal considerations.

All-Electric vehicles (1.5 lectures)

There are two main areas where the all-electric vehicle is being considered. The first is in aircraft where considerable advantage can be gained from the removal of mechanical systems which require bulky and expensive cooling systems and the replacement of these by electric motors and generators. The second is the electric car, where the goal is to remove pollution from the streets of busy towns. These lectures will explore the problems and the practicalities of these systems.

Single-phase motors (1.5 lectures)

Single-phase induction motors - split-phase, capacitor-start, permanent split capacitor, shaded-pole variants, ac commutator motors.

Three-phase motors (2 lectures)

Voltage source and current source, variable frequency three-phase induction motor drives. Open and closed-loop control schemes for induction motor drives. Analysis of the drive in the steady state.

Reluctance machines (2 lectures)

Salient-pole synchronous machines, stepper motor single-step and multi-step operation, switched-reluctance motors - principles of operation, behaviour, applications. Variable frequency operation and principal control strategies.

Permanent magnet machines (2 lectures)

Brushed and brushless motors, magnet materials (power/weight, cost, type), general principles of operation.

Mechatronics design (3 lectures)

Multiplexing of mutiple drive machines. Such as in robotics or rolling mills

Coursework

Robotic Steering

Learning objectives:

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Practical information:

- Sessions will take place in [Location], during week(s) [xxx].
- This activity [involves/doesn't involve] preliminary work ([estimated duration]).
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Full Technical Report:

Students [will/won't] have the option to submit a Full Technical Report.

Booklists

Please see the Booklist for Part IIA Courses [2] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [4] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

D4

Ability to generate an innovative design for products, systems, components or processes to fulfil new needs.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

E2

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

E3

Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US2

A comprehensive knowledge and understanding of mathematical and computer models relevant to the engineering discipline, and an appreciation of their limitations.

US3

An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

US4

An awareness of developing technologies related to own specialisation.

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