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

Module Leader
Dr T Flack

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 electrical motor drives in household 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 permanent 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 different motors for different applications.
- Understand the design constraints 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)**


**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 multiple 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

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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