Engineering Tripos Part IIA, 3B3: Switch-mode Electronics, 2017-18

Module Leader
Dr T Long

Lecturers
Dr P Palmer and Dr T Long

Lab Leader
Dr T Long

Timing and Structure
Michaelmas term. 2 lectures/week.

Aims
The aims of the course are to:

- Introduce power electronics as an interface technology.
- Introduce power semiconductor devices and circuits, describing their use in a range of applications includin rectification, linear and switch-mode power supplies, a.c. power control circuits and dc-ac inverters using pulse-width modulation.

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

- Know the characteristics of the diode and how to use diodes in rectifier circuits to obtain d.c. from single and three-phase a.c.
- Know how to reduce ripple using smoothing circuits.
- Know the characteristics of the thyristor and how to use the thyristor in controlled rectifiers operating from single or three-phase supplies.
- Be able to explain the conditions under which inversion, i.e. the flow of power from the d.c. to the a.c. side, takes place.
- Appreciate the relative merits of MOSFETs, IGBTs and bipolar transistors as switches.
- Be aware of the principal types of converter circuit and their characteristics.
- Know the principle of pulse-width modulation and simple ways of generating pulse-width modulated waveforms.
- Be familiar with three-phase inverter circuits using pulse-width modulation.
- Be familiar with the essential elements of a complete switch-mode power supply.
- Be able to analyse the operation of a simple SMPS.
- Describe the various losses and estimate the efficiency of a Power Electronic System.
- Appreciate the role of power electronic converters in various applications.

Content
• The diode; simple rectifier circuits using diodes. Three-phase rectification. Smoothing circuits and waveform distortion. Regulated supplies using linear circuit techniques.
• The thyristor. Controlled rectification and inversion using thyristors.
• The MOSFET, IGBT and bipolar transistor as power switches.
• Basic switching converter configurations: the up and down converters. The concept of pulse width modulation; the generation of pulse-width modulated waveforms. Converters with isolation. Introduction to magnetics and components.
• Power losses in converters. ZCS and ZVS Resonant converters.
• Outline design for a complete switch-mode power supply including power factor correction.
• Half and full bridge circuits. Deadtime and the problem of the high side drive. The application of chopper circuits in DC motor drives.
• Single phase and three-phase inverter circuits. Variable voltage variable frequency three-phase inverter for use in induction motor drives.
• Transient Analysis in circuits.

Coursework

Switch-Mode Electronics

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]).

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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Links
[1] mailto:tl32t@cam.ac.uk