Engineering Tripos Part IIB, 4B2: Power Microelectronics, 2020-21

Module Leader

Prof F Udrea [1]

Lecturer

Prof F Udrea

Timing and Structure

Michaelmas term. 14 lectures + 2 examples classes. Assessment: 100% exam.

Prerequisites

3B3 & 3B5 useful

Aims

The aims of the course are to:

- provide an introduction to the world of modern power semiconductor devices, and their applications in the electronics Industry.
- cover material specific to power semiconductor devices not covered in other modules in semiconductors.

Objectives

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

- understand how the design of power semiconductor devices takes account of high voltage and currents
- explain the practical operating conditions pertaining to power semiconductor devices
- analyse power circuit segments
- know the features of the main types of power electronic devices
- understand the semiconductor technologies in power devices

Content

Introduction

Introduction to power electronics and power devices. Basics of power electronics, power devices and applications. P-N junction theory.

Power Diodes

High voltage pn junction theory. Breakdown theory. None punch-through (NPT) and punch-through (PT) high voltage junction. On-state - high level injection. Lifetime. Turn-off reverse recovery

Field Control
Curvature effects in high voltage junctions, Edge effects, Field plates, Terminations in power devices.

**Power Bipolar Devices**
Bipolar Junction Transistor (BJT).

**Thyristors**
The thyristor (concept & technology). The GTO thyristor, Switching aids for transistors and thyristors.

**Power MOS Devices**
The power MOSFE: Concept, modes of operation. Trade-offs.

**Power MOSFET Modelling**
The power MOSFET modelling, technologies and advanced devices.

**Insulated Gate Bipolar Transistors**
The Insulated Gate Bipolar Transistor (IGBT): modes of operation. Trade-offs.

**IGBTs II**
The IGBTs, modelling, technologies and advanced concepts.

**Power Integrated Circuits (PICs)**
Power Integrated Circuits (PICS) and High Voltage Integrated Circuits (HVICs): introduction, lateral devices for PICs and HVICs, concepts, modes of operation.

**Coursework**
Optional - Finite element design and analysis of novel high voltage devices in the HVM Lab led by Dr F Udrea

**Booklists**
Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

**Examination Guidelines**
Please refer to Form & conduct of the examinations [2].

**UK-SPEC**
The UK Standard for Professional Engineering Competence (UK-SPEC) [3] 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 [4] which sets out the standard for degree accreditation.
The Output Standards Matrices [5] 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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