

Engineering Tripos Part IIA Project, GB2: Electrical Power, 2023-24

Leader

[Prof F Udrea](#) [1]

Timing and Structure

Thursdays 11-1pm and Mondays 9-11am plus afternoons

Prerequisites

3B3

Aims

The aims of the course are to:

- To introduce the techniques of conceptual design process.
- To introduce and develop methods for optimising designs through iteration of design equations.
- To gain an appreciation of the factors influencing power component designs.
- To have hands-on experience on developing and testing power electronic apparatus by prototyping AC/DC and DC/DC converters

Objectives

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

- Understanding the requirement specification and having an appreciation of technical challenges
- Identifying specific tasks for each group member and managing teamwork progress
- Having practice on making power electronic circuits, including modelling, device selection, gate drive circuitry, coding and digital controller implementation, passive components design and making.
- Having practice on testing power electronic circuits, including instrumentation, sense for measurement

Content

This project will involve students in a wide variety of design issues within electrical engineering. Included are circuit design using integrated circuits, power semiconductor device circuits and the design of a transformer suitable for use with non-sinusoidal supplies.

A tight specification will be given for a prototype 24V dc to 110V ac (50Hz), 100W inverter for use as an emergency power supply in the event of mains failure. Simple calculations for the designs of each stage will be iterated such that a satisfactory solution is obtained. A complete inverter will be made by each group and thoroughly tested to establish whether it meets the specification.

Student will have excises in circuit modelling (LTSpice, PLECS) and PCB design (KiCAD).

This project will offer students experience and skills for power electronics hardware development. Real power electronic devices and their applications and features will be introduced.

Aims:

Technical interpretation and design specification

- Understand the general requirements and transfer them to technical specifications
- Define design requirements: ratings, architecture, bill of materials (BoM), high frequency transformer design

Applications notes and datasheet

- Fill the gap between theories and realisation by using application notes and datasheet
- Find and understand important parameters from datasheet

Week 1

Conceptual design.

Week 2

Design and build converter circuits for dc to dc and ac to dc conversion (Group report 1)

Week 3

Test converter circuits and integrate (Group report 2).

Week 4

Final assembly and test (Individual final report).

MINI LECTURES

Three or four mini lectures will be presented covering:

- Introduction to the GB2 project
- Gate driver and Transformer design.
- Introduction to power semiconductor devices.
- Introduction to bootstrap architectures

Circuits and methods

A detailed handbook and a collection of datasheets is given to each student. One practical design is outlined but there is no bar to using other designs if they are sensible. The datasheets are distributed simply to help with the conceptual design stage and no limit is placed on the availability of components. Following the conceptual design report, students may be encouraged or otherwise from following a particular path. Hence it may be expected that each group will produce a working inverter. Use of computers is encouraged, particularly for optimisation of the transformer design. Good quality general purpose electrical and electronic engineering facilities are available.

Coursework

Coursework	Due date	Marks
Interim report 1	4pm 23 May 2024	15
Interim report 2	4pm 30 May 2024	25
Final report	4pm 7 June 2024	40

Booklists

Recommended:

<https://www.fairchildsemi.com/application-notes/AN/AN-6076.pdf> [2]

<http://www.ti.com/lit/ml/slva618/slva618.pdf> [3]

Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [4].

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Links

[1] <mailto:fu10000@cam.ac.uk>

[2] <https://www.fairchildsemi.com/application-notes/AN/AN-6076.pdf>

[3] <http://www.ti.com/lit/ml/slva618/slva618.pdf>

[4] <https://teaching23-24.eng.cam.ac.uk/content/form-conduct-examinations>