OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

ENGINEERING

Cambridge TECHNICALS

A PROJECT APPROACH TO DELIVERY – ELECTRIC VEHICLES AND THE GREENPOWER IET FORMULA 24+ PROJECT

Version 1

Greenpower
INSPIRING ENGINEERS

ocr.org.uk/engineering

CONTENTS

INTRODUCTION

The purpose of this guide is to give you an overview of how you could holistically deliver a range of units from Cambridge Technicals in Engineering Level 3 (Electrical and Electronic Engineering pathway) in conjunction with aspects of the Greenpower IET Formula 24+ class competition.

Link to qualification: http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

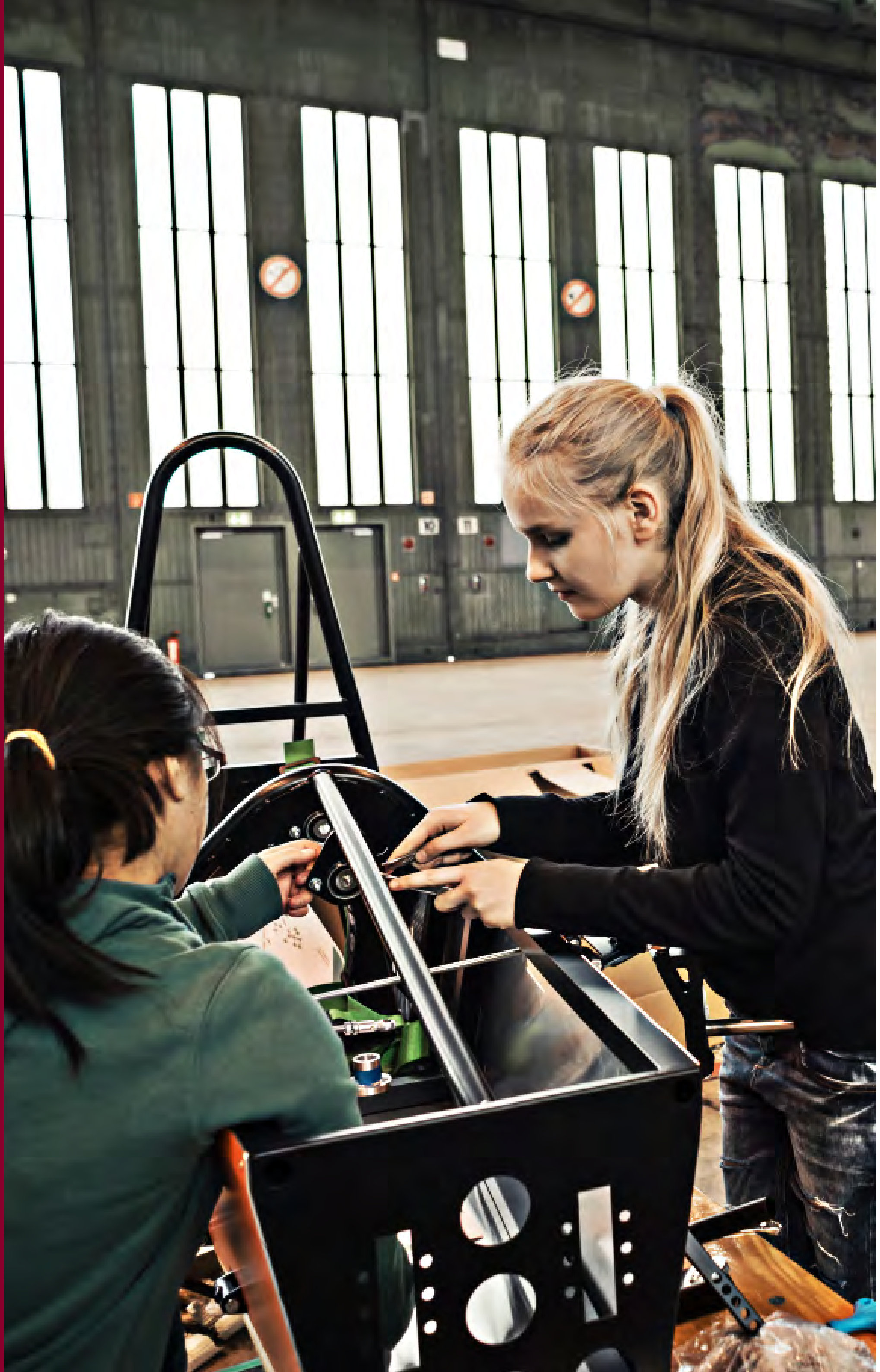
The intention is for learners to undertake investigation, analysis, design, simulation, manufacture and fault finding tasks relevant to electrical and electronic engineering. These are in the context of an electric vehicle and so could complement the production and augmentation of a vehicle that might participate in the IET Formula 24+ class competition.

When delivering any qualification it is always useful to be able to look at the full range of units selected and consider how they are or could be linked together – a holistic or Project Approach.

A holistic or Project Approach will provide you with a structured plan to teach the learners how a range of topics work together across a number of units, providing them with some understanding of how skills and knowledge link together in a working environment.

THIS PROJECT APPROACH ENABLES THE DELIVERY AND FACILITATION OF LEARNING OF THE FOLLOWING UNITS:

Unit		LO	
Unit 5	Electrical and electronic design	LO1	Be able to apply AC and DC circuit theory to circuit design
		LO2	Understand the application of electromagnetism in electrical design
		LO3	Be able to apply a systems approach to electrical design
		LO4	Be able to use semi-conductors in electrical and electronic design
		LO5	Understand the application of programmable process devices in electronic design
Unit 6	Circuit simulation and manufacture	LO1	Be able to use Computer Aided Design (CAD) for circuit design and simulation
		LO2	Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs)
		LO3	Be able to manufacture and construct electronic circuits safely
		LO4	Be able to test and perform fault-finding on electronic circuits
		LO5	Understand commercial circuit manufacture
Unit 7	Electrical devices	LO1	Understand semi-conductor and programmable devices
		LO2	Understand electrical sensors and actuators
		LO3	Understand how to use signal conditioning techniques and signal conversion devices
		LO4	Understand the application of smart and modern materials in electrical devices
Unit 8	Electrical operations	LO1	Understand operating and performance characteristics of electrical and electronic components and devices
		LO2	Be able to work safely with electricity
		LO3	Be able to construct electrical and electronic circuits
		LO4	Be able to fault find in electrical and electronic equipment



The intention is that the learners will be taught a range of knowledge and skills within each of the units and then carry out relevant review activities at various stages. Each of the review activities (once successfully completed by the learner) will provide all the required underpinning knowledge for their final assessment.

The practice review activities within the modules must not be used for final assessment purposes of Cambridge Technicals in Engineering.

Model assignments for each of the mandatory internally assessment units (Units 5, 6, 9, 10, 14, 15, 16, 17, 18, 19) for Cambridge Technicals in Engineering Level 3 units can be found at http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

It is assumed that the learners will be given the opportunity to carry out activities that will enable them to practice the skills they have learned within each module prior to being given final assessment activities.

When considering a holistic or Project Approach to delivery and learning it is important to consider the overall objectives. In this guide the objectives are to:

- Deliver four units of Cambridge Technicals in Engineering Level 3.
- Structure a programme of learning and reviews which is exciting and engaging for learners.
- Provide learners with an overview of how the knowledge and skills gained in one unit, support the knowledge and skills used within other units.
- Provides learners with an opportunity to consider how they could use their social and communications skills holistically within the working environment.

A WORD ABOUT GREENPOWER EDUCATION TRUST

At Greenpower Education Trust we believe that providing young people with an exciting, real life project is the most successful way of sparking an interest in engineering, helping to address the serious skills gap the UK faces in this crucial business sector.

Our highly successful challenge, to design, build and race a single seat electric car uses the excitement of motorsport to inspire students from primary school through to university to excel in Science, Technology, Engineering and Maths (STEM) studies.

Over 12,000 students and 500 schools/organisations take part in 30 Greenpower-organised race days each year, held at prestigious locations all over the UK.

The basis of the challenge across four distinct age groups (9-25yrs) is the same – to design, build and race a single seat electric race car. The challenge for 16-25yrs, IET Formula 24+, sees teams of young people either using a kit car from Greenpower, or, using supplied motor and batteries only, building a car within Greenpower's safety regulations to compete in a 60 minute race as part of a championship, aiming to be the car that completes the furthest distance within that time on just one set of batteries.

Teams come from a range of backgrounds; colleges, universities, UTCs, private teams and corporate apprentice and graduate teams. The participation of corporate teams adds a further dimension to the programme, allowing younger students to interact with real-world apprentices and graduates and find out about the fascinating careers available across all STEM subjects.

Greenpower is unique among STEM enrichment providers in running the same basic concept through such a wide age group, allowing for excellent progression throughout.

Now, the project has additional educational value through working with OCR to map the IET Formula 24+ category to the Cambridge Technicals qualifications.

Greenpower and OCR provide a perfect platform for a holistic approach to teaching, through fascinating and relevant project-based learning – what better way to inspire everyone involved than through this unique programme to design, build and race an electric car?

http://www.greenpower.co.uk/

GREENPOWER AND OCR

OCR and Greenpower both recognise that project approach learning encourages students to think differently about how to apply their knowledge of science, technology engineering and mathematics to 'real life' challenges through projects.

We both strive to promote independent thinking and problem solving through our work and are committed to bringing exciting education into the classroom.

Challenging projects such as Greenpower support the technical content of qualifications such as Cambridge Technical in Engineering and contextualised learning makes the experience 'real' and relevant.

The modules taught in classrooms provide teachers with a structured plan to demonstrate how a range of topics work together across the syllabus, providing student with an understanding of how skills and knowledge could link together in a working environment.

Furthermore it gives students the opportunity to interact with a wide range of practitioners with specialisms in different disciplines within a particular sector which should inspire learners to formulate career plans.

More information and resources on our Cambridge Technicals are available at http://www.ocr.org.uk/qualifications/by-type/cambridge-technicals/

ABOUT THE MODULES AND ACTIVITIES

The guide is divided into five modules which may be sub-divided or combined according to the teaching time available.

The tables below show where each of the modules in this project provides delivery approaches and learning opportunities to ensure a thorough review of skills and understanding, prior to final assessment and evidencing by the learner.

Please note that should assessment be presented in a similar holistic way, learners must be able to present clearly mapped evidence for each of the centre-assessed units (Unit 5, Unit 6, Unit 7 and/or Unit 8).

BY UNIT/LEARNING OUTCOME (LO)

	LO1	LO2	LO3	LO4	LO5
Unit 5	Module 1 Activity 1 to 4 Module 2 Activity 2, 3 Module 3 Activity 3 Module 4 Activity 3	Module 1 Activity 3 Module 2 Activity 2, 4 Module 3 Activity 2	Module 1 Activity 2 Module 2 Activity 3 Module 3 Activity 1, 2 Module 4 Activity 1, 3 Module 5 Activity 3	Module 2 Activity 3 Module 3 Activity 1 to 3 Module 4 Activity 1 to 3	Module 5 Activity 1
Unit 6	Module 3 Activity 3, 4 Module 4 Activity 3, 4	Module 3 Activity 4 Module 4 Activity 4	Module 3 Activity 4 Module 4 Activity 4	Module 3 Activity 4 Module 3 Activity 4	Module 5 Activity 2
Unit 7	Module 2 Activity 3 Module 3 Activity 1 to 3 Module 4 Activity 1 to 3 Module 5 Activity 5	Module 3 Activity 2, 3 Module 4 Activity 3 Module 5 Activity 3	Module 3 Activity 2, 3 Module 4 Activity 3 Module 5 Activity 3	Module 5 Activity 4	
Unit 8	Module 1 Activity 2 to 4 Module 2 Activity 1 to 3 Module 3 Activity 3, 4 Module 4 Activity 3, 4 Module 5 Activity 1 to 3	Module 1 Activity 3, 4 Module 2 Activity 1 to 3 Module 3 Activity 3, 4 Module 4 Activity 3, 4	Module 1 Activity 3 to 4 Module 2 Activity 1 to 3 Module 3 Activity 3, 4 Module 4 Activity 3, 4	Module 1 Activity 3, 4 Module 2 Activity 1 to 3 Module 3 Activity 3, 4 Module 4 Activity 3, 4	

BY MODULE

	Unit	LO
Module 1	Unit 5	LO1 Activity 1 to 4 LO2 Activity 3 LO3 Activity 2
	Unit 8	LO1 Activity 2 to 4 LO2 Activity 3, 4 LO3 Activity 3, 4 LO4 Activity 3, 4
Module 2	Unit 5	LO1 Activity 2, 3 LO2 Activity 2, 4 LO3 Activity 3 LO4 Activity 3
	Unit 7	LO1 Activity 3
	Unit 8	LO1 Activity 1 to 3 LO2 Activity 1 to 3 LO3 Activity 1 to 3 LO4 Activity 1 to 3

	Unit	LO
Module 3	Unit 5	LO1 Activity 3 LO2 Activity 2 LO3 Activity 1, 2 LO4 Activity 1 to 3
	Unit 6	LO1 Activity 3, 4 LO2 Activity 4 LO3 Activity 4 LO4 Activity 4
	Unit 7	LO1 Activity 1 to 3 LO2 Activity 2, 3 LO3 Activity 2, 3
	Unit 8	LO1 Activity 3, 4 LO2 Activity 3, 4 LO3 Activity 3, 4 LO4 Activity 3, 4

	Unit	LO
Module 4	Unit 5	LO3 Activity 3 LO5 Activity 1
	Unit 6	LO1 Activity 3, 4 LO2 Activity 4 LO3 Activity 4 LO4 Activity 4
	Unit 7	LO1 Activity 1 to 3 LO2 Activity 3 LO3 Activity 3
	Unit 8	LO1 Activity 3, 4 LO2 Activity 3, 4 LO3 Activity 3, 4 LO4 Activity 3, 4
Module 5	Unit 5	LO3 Activity 3 LO5 Activity 1
	Unit 6	LO5 Activity 2
	Unit 7	LO1 Activity 5 LO2 Activity 3 LO4 Activity 3 LO4 Activity 4
	Unit 8	LO1 Activity 1 to 3

Where possible this Project Approach would benefit from practical experiments and activities, with the intention that learners produce an electric car.

Please note that this Project Approach should not be used directly for assessment purposes. It is intended to support the teaching and learning of the units specified.

ASSESSMENT OF UNITS

This project provides opportunities to produce evidence to meet the assessment requirements of Unit 5, 6, 7 and 8.

This is summarised in the table above which indicates how each Module and Activity provides an opportunity for additional and separate evidence for each unit. Completion of the modules does not guarantee all criteria have been met; this is entirely dependent on the quality of the evidence produced.

This Project Approach should be read in conjunction with the published grading criteria in the Unit documents.

DELIVERING THE PROJECT HOLISTICALLY

This Project Approach provides a direct opportunity to deliver the following units in the Electrical and Electronic Engineering pathway holistically:

- Unit 5 Electrical and electronic design
- Unit 6 Circuit simulation and manufacture
- Unit 7 Electrical devices
- Unit 8 Electrical operations

It also provides opportunities to include further units into its synoptic delivery including, but not limited to:

- Unit 1 Mathematics for engineering
- Unit 2 Science for engineering
- Unit 3 Principles of mechanical engineering
- Unit 4 Principles of electrical and electronic engineering
- Unit 9 Mechanical design
- Unit 10 Computer Aided Design (CAD)
- Unit 11 Materials science
- Unit 12 Mechanical simulation and modelling
- Unit 13 Mechanical operations
- Unit 22 Engineering and the environment

Examples of how these further units might be related to this Project Approach are included in the Opportunities for holistic delivery of other units section .

THE PROJECT BRIEF

The learner version of the Project Brief is available from http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

Learners have been asked to analyse aspects of the electric car, and design and build complementary electrical and electronic circuits.

Learners will use electrical and electronic engineering concepts to:

- Analyse battery technologies used in electric vehicles.
- Investigate battery charging and battery charging circuits.
- Investigate battery charging using alternative forms of energy.
- Evaluate the application of motors for propulsion.
- Evaluate solid state motor speed control.
- Design, simulate, built and test an electric vehicle speed monitoring system.
- Design, simulate, built and test an electric vehicle warning sound system.
- Investigate and evaluate technologies being used in commercial vehicles.

This work can be undertaken as an individual or within a team. If working within a team learners are expected to contribute to each of the areas (and be able to evidence this contribution) in order to gain the experience and knowledge required to successfully complete the Cambridge Technicals Engineering Level 3 (Electrical and Electronic Engineering pathway) units.

Electric vehicles (EVs) use electric motors typically powered by rechargeable batteries to provide propulsion. EVs include road and rail vehicles, surface and underwater vehicles. The electric car is one example of a battery electric vehicle (BEV) that is becoming increasingly popular due to its clean quiet operation and environmentally-friendly zero emissions.

The Greenpower project encourages learners to design, build and race their own electric car within professionally drafted specifications. Events are arranged at a number of major motor racing circuits. All Greenpower classes use a 24 V, 240 W electric motor and pairs of 12 volt rechargeable batteries. The IET Formula 24+ class is for young people aged 16-25. See http://www.greenpower.co.uk/ for more details.

Learners will engage with a range of design techniques, including the application of electrical and electronic components and devices. Circuit design and simulation software (CAD) will be used to design, simulate and evaluate circuits, and to produce printed circuit boards (PCBs). Learners will develop practical construction and fault finding skills relevant to electrical and electronic engineering.

MODULE 1

POWERING ELECTRIC VEHICLES: BATTERIES AND BATTERY CHARGING

Link to qualification: http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

The delivery begins with Unit 5 Electrical and Electronic Design (LO1, LO2 and LO3).

Before learners can begin the electrical and electronic analysis, evaluation and design processes for the electric car, or for any other electrical/electronic system, they first need to have a good understanding of:

- circuit theory relevant to the design of AC and DC circuits
- the applications of electromagnetism in electrical design
- how a systems approach is used in electrical design.

Contained within the following assessment criteria/LO(s)/units:

Learning Outcome	LO number	Unit number
Be able to apply AC and DC circuit theory to circuit design	LO1	Unit 5
Understand the application of electromagnetism in electrical design	LO2	Unit 5
Be able to apply a systems approach to electrical design	LO3	Unit 5

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

PRACTICE REVIEW ACTIVITIES FOR MODULE 1

ACTIVITY 1

Learners could investigate batteries and battery technologies used in electric cars – including those specified in the IET Formula 24+ project.

This could include analysis of design specifications (e.g. for the IET Formula 24+ project) and electrical and physical properties using data sheets. The following data is for the Greenpower batteries: http://www.yuasa.co.uk/batteries/industrial/rec-vrla-cyclic-use/rec36-12-rec36-12.html

ACTIVITY 2

Learners could evaluate the methods by which batteries are charged. This could include development of system block diagrams, and more detailed circuit diagrams showing key components in a battery charging circuit (e.g. transformer, rectifier, smoothing capacitors, voltage regulators and circuit protection).

ACTIVITY 3

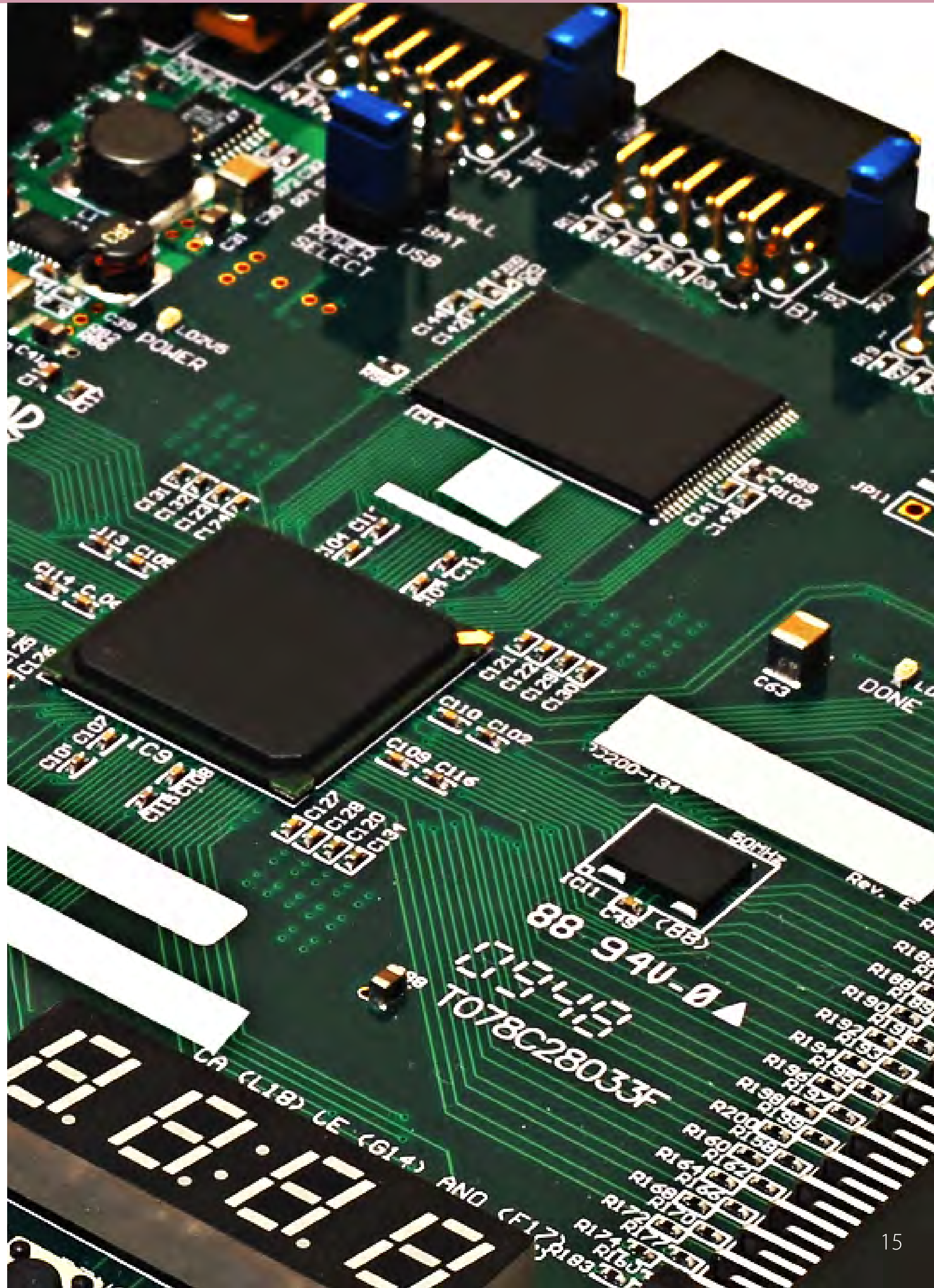
Learners could analyse in detail the operation of battery charging circuits, including relevant AC and DC theory. Analysis could also include methods of circuit protection, and design consideration for electromagnetic compatibility. The following describes a typical charging circuit: http://www.eleccircuit.com/the-most-lead-acid-battery-charger-circuit-by-lm317/

Practical experiments could be performed to determine characteristics and operation of a battery charging circuit.

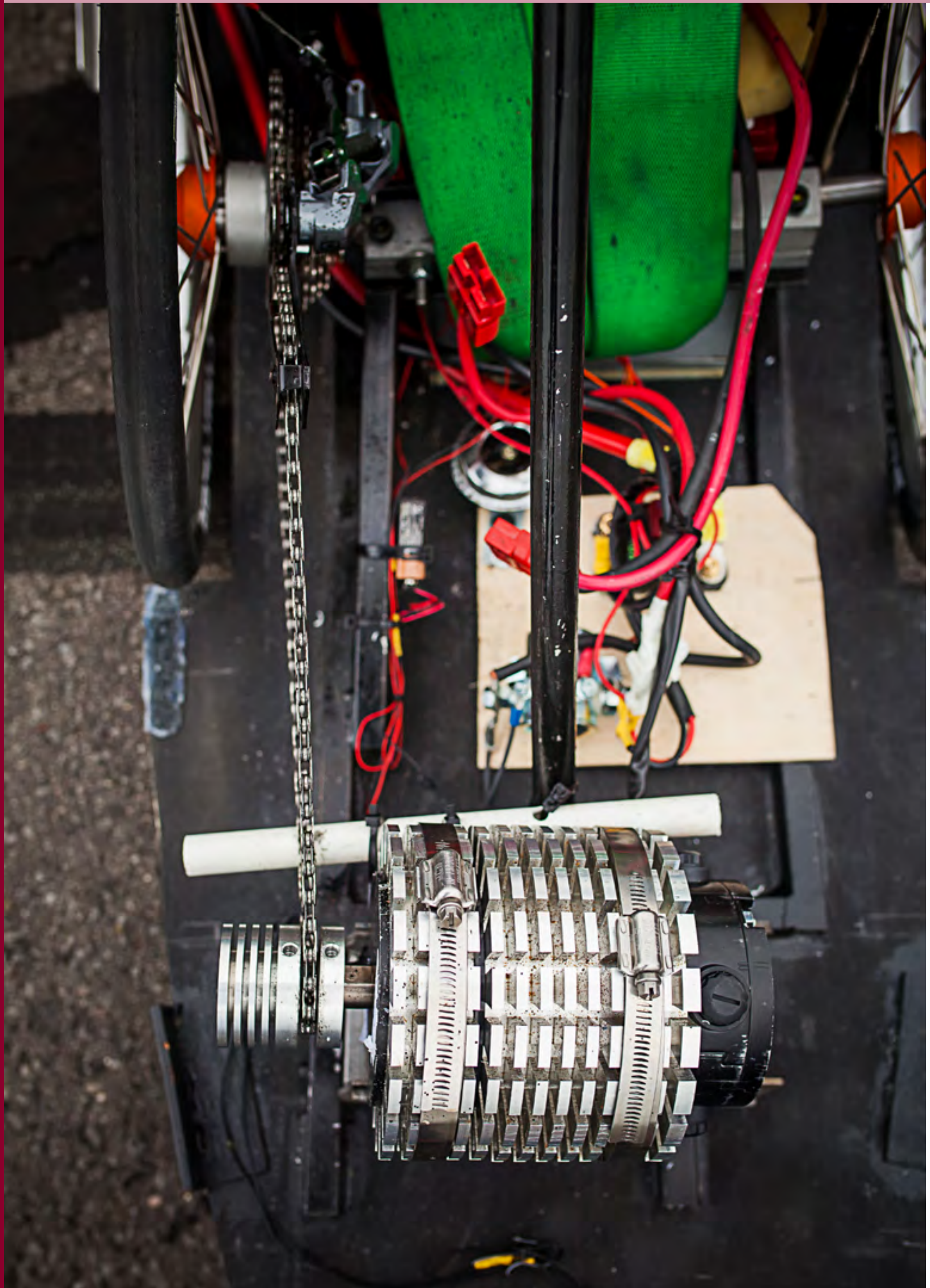
ACTIVITY 4

Learners could investigate how alternative sources of energy might be used for battery charging (e.g. solar photo-voltaic cell). The IET Formula 24+ project regulations allow alternative methods to be used (see regulations at http://www.greenpower.co.uk/)

Practical experiments could be performed to evaluate alternative charging devices and circuits.



MODULE 2



PROPULSION: MOTORS AND MOTOR SPEED CONTROL

Link to qualification: http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

The delivery then continues through Unit 5 (LO1, LO2, LO3 and LO4) into Unit 7 (LO1).

Learners will continue to apply the following to the analysis, evaluation and design processes for the electric car:

- circuit theory relevant to the design of AC and DC circuits
- the applications of electromagnetism in electrical design
- how a systems approach is used in electrical design.

They will also consider:

- the application of semi-conductors in electrical and electronic design
- further semi-conductor and programmable devices.

Contained within the following assessment criteria/LO(s)/units:

Learning Outcome	LO number	Unit number
Be able to apply AC and DC circuit theory to circuit design	LO1	Unit 5
Understand the application of electromagnetism in electrical design	LO2	Unit 5
Be able to apply a systems approach to electrical design	LO3	Unit 5
Be able to use semi-conductors in electrical and electronic design	LO4	Unit 5
Understand semiconductor and programmable devices	LO1	Unit 7

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

PRACTICE REVIEW ACTIVITIES FOR MODULE 2

ACTIVITY 1

Learners could investigate motors used in the propulsion of electric cars – including those specified in the IET Formula 24+ project. This might include analysis of specifications (e.g. for the IET Formula 24+ project) and electrical and physical characteristics using data sheets.

ACTIVITY 2

Learners could perform practical experiments to determine the characteristics and performance of a DC motor suitable for electric car propulsion. Experiments could include torque and speed characteristics, current drawn and performance with varying voltage.

Learners could evaluate the characteristics of the motor specified for the IET Formula 24+ project (http://www.greenpower.co.uk/sites/default/files/GreenpowerF24PerformanceGraph%5B1%5D.pdf)

Learners could also explore regeneration of energy (i.e. motor acting as a generator).

ACTIVITY 3

Learners could analyse in detail the operation of a motor speed controller, including the application of semiconductor devices (e.g. metal–oxide–semiconductor field-effect transistor or MOSFET). Systems block diagrams might be developed, including inputs, outputs and control elements. Methods of circuit protection could be compared and analysis might include programmable devices used in the speed controller. Experiments could be performed to determine characteristics, operation and performance of a speed controller.

Learners could evaluate a range of motor speed controllers designed for the IET Formula 24+ project e.g. http://www.4qd.co.uk/evs/greenpower.html and http://www.greenpower.beamweb.co.uk/groups/electronics/GpSpeed/index.html

ACTIVITY 4

Learners could investigate electromagnetic compatibility (EMC) in the context of motor speed control. Simple experiments using an AM radio could be used to determine sources of interference (e.g. http://electronics.stackexchange.com/questions/21097/simple-radiated-emc-measurement)

Methods for mitigation of interference could be evaluated (e.g. filters, screening).

MODULE 3

MONITORING VEHICLE SPEED

Link to qualification: http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

This module synthesizes knowledge and skills across a range of units – Unit 5 (LO1, LO2, LO3, and LO4), Unit 6 (LO1, LO2, LO3 and LO4), Unit 7 (LO2 and LO3), Unit 8 (LO1, LO2, LO3 and LO4).

Learners will apply the following design, construction and test processes to a speed monitoring system for the electric car:

- circuit theory relevant to the design of AC and DC circuits
- a systems approach to electrical design
- application of electrical and electronic components
- evaluation and application of sensors, signal conditioning and interfacing
- circuit design and simulation using CAD
- PCB design and manufacture
- circuit fault-finding and testing
- safe practical construction skills.

Contained within the following assessment criteria/LO(s)/units:

Learning Outcome	LO number	Unit number
Be able to apply AC and DC circuit theory to circuit design	LO1	Unit 5
Understand the application of Electromagnetism in electrical design	LO2	Unit 5
Be able to apply a systems approach to electrical design	LO3	Unit 5
Be able to use semi-conductors in electrical and electronic design	LO4	Unit 5
Understand electrical sensors and actuators	LO2	Unit 7
Understand how to use signal conditioning techniques and signal conversion devices	LO3	Unit 7
Be able to use Computer Aided Design (CAD) for circuit design and simulation	LO1	Unit 6
Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs)	LO2	Unit 6
Be able to manufacture and construct electronic circuits safely	LO3	Unit 6
Be able to test and perform faultfinding on electronic circuits	LO4	Unit 6
Understand operating and performance characteristics of electrical and electronic components and devices	LO1	Unit 8
Be able to work safely with electricity	LO2	Unit 8
Be able to construct electrical and electronic circuits	LO3	Unit 8
Be able to fault find in electrical and electronic equipment	LO4	Unit 8

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

PRACTICE REVIEW ACTIVITIES FOR MODULE 3

ACTIVITY 1

Learners could investigate, analyse and compare circuits for monitoring, displaying and recording vehicle speed. There are many examples on the Internet e.g. http://www.brighthubengineering.com/diy-electronics-devices/123919-bicycle-speed-indicator-circuit-explained/#imgn_0

A table of key features could be produced to evaluate designs already available. This could result in a final design being selected. Learners might produce system block diagrams and analyse in detail operation of a final circuit design.

ACTIVITY 2

Learners could evaluate a range of sensors, selecting ones that might be used to determine speed of an electric car (such as the car for the IET Formula 24+ project). This could include analogue sensors (e.g. tachogenerator) and/or digital sensors (e.g. optical encoder or inductive sensor). Experiments could be performed to determine characteristics and operation of a range of sensors.

ACTIVITY 3

Learners could use circuit schematic design and simulation software (CAD) to design and simulate a speed monitoring and display circuit. This could include aspects of analogue and/or digital design, application of a range of electronic devices, and interfacing of suitable input sensors and output display devices. Learners could adapt and improve on existing designs.

ACTIVITY 4

Learners could use design software (CAD) to design and manufacture a suitable printed circuit board (PCB). The PCB could be constructed and tested. The performance of the final working circuit could be evaluated through experimentation. Improvements to the circuit design and construction could be considered and/or implemented. The final design could be used to measure the speed of an IET Formula 24+ electric car.

MODULE 4

ELECTRIC VEHICLE WARNING SOUNDS

Link to qualification: http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

This module again synthesizes knowledge and skills across a range of units – Unit 5 (LO1, LO2, LO3, and LO4), Unit 6 (Lo1, LO2, LO3 and LO4), Unit 7 (LO2 and LO3), Unit 8 (LO1, LO2, LO3 and LO4).

Learners will apply the following design, construction and test processes to a warning sound generating system for the electric car:

- circuit theory relevant to the design of AC and DC circuits
- a systems approach for electrical design
- use of electrical and electronic components
- circuit design and simulation using CAD
- PCB design and manufacture
- circuit fault-finding and testing
- practical safe construction skills.

Contained within the following assessment criteria/LO(s)/units:

Learning Outcome	LO number	Unit number
Be able to apply AC and DC circuit theory to circuit design	LO1	Unit 5
Be able to apply a systems approach to electrical design	LO3	Unit 5
Be able to use semi-conductors in electrical and electronic design	LO4	Unit 5
Be able to use Computer Aided Design (CAD) for circuit design and simulation	LO1	Unit 6
Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs)	LO2	Unit 6
Be able to manufacture and construct electronic circuits safely	LO3	Unit 6
Be able to test and perform fault finding on electronic circuits	LO4	Unit 6
Understand operating and performance characteristics of electrical and electronic components and devices	LO1	Unit 8
Be able to work safely with electricity	LO2	Unit 8
Be able to construct electrical and electronic circuits	LO3	Unit 8
Be able to fault find in electrical and electronic equipment	LO4	Unit 8

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

PRACTICE REVIEW ACTIVITIES FOR MODULE 4

ACTIVITY 1

Learners could begin by investigating the requirements for a warning sound system in electric cars (including legislative for commercial vehicles i.e. http://www.dailymail.co.uk/news/article-2595451/Silent-deadly-EU-rules-electric-cars-make-artificial-engine-noise-fears-kill-unsuspecting-pedestrians.html).

They could analyse and compare electronic circuits used to generate and amplify sound. A range of designs may be found using the Internet e.g. http://www.talkingelectronics.com/projects/DieselSound/DieselSound-1.html

A table of key features could be produced to evaluate designs already available. This could result in a range of final design solutions being produced along with system block diagrams.

ACTIVITY 2

Learners could evaluate a range of sensors, such as speed sensing devices that might be used to alter the audio tone with speed of the vehicle, and/or position sensing devices to detect obstructions. Experiments could be performed to determine characteristics and operation of a range of sensors.

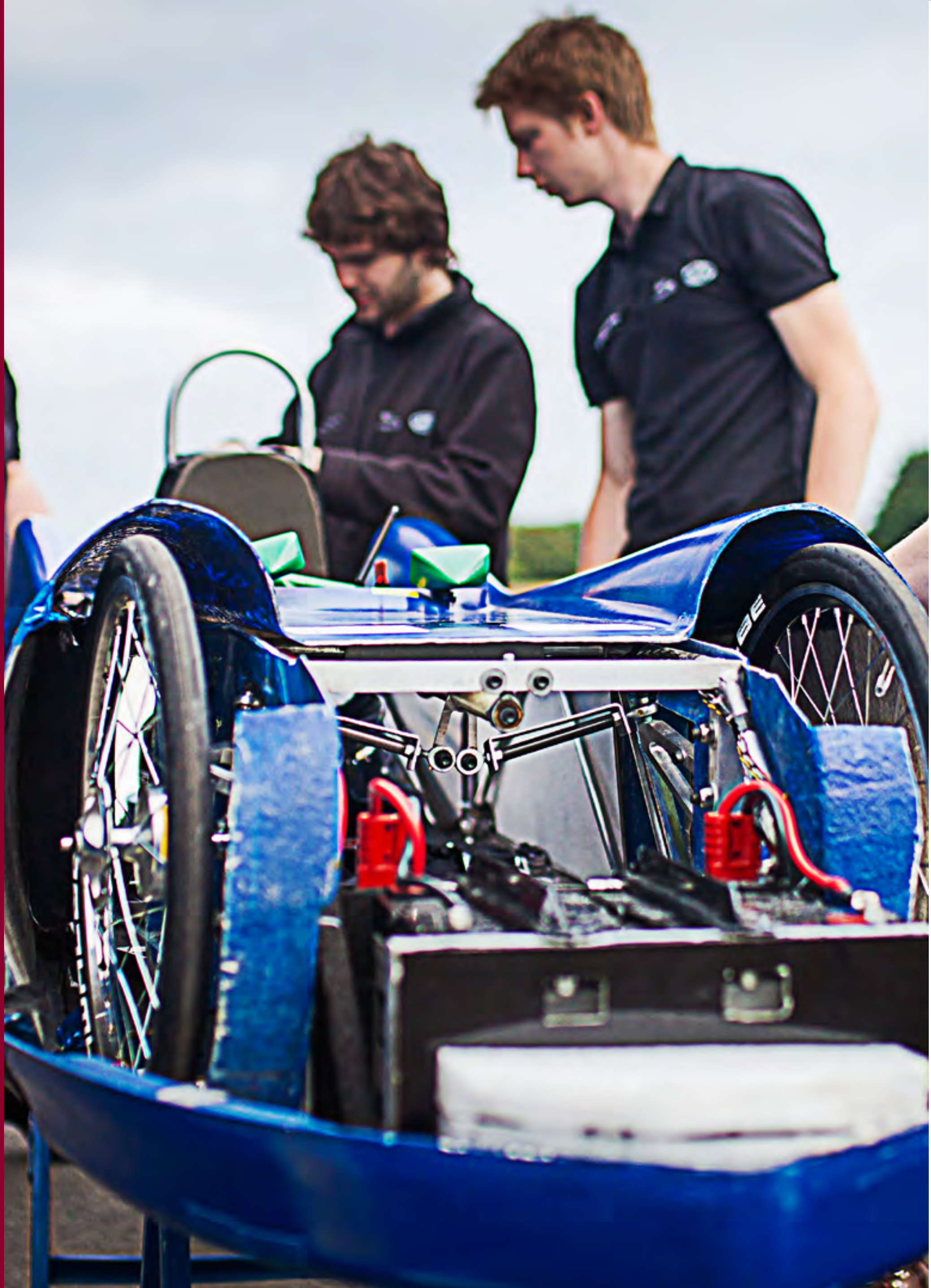
ACTIVITY 3

Learners could use circuit schematic design and simulation software (CAD) to design and simulate a warning sound circuit. This could include aspects of analogue and/or digital design, application of a range of electronic devices, use of filtering techniques and methods of audio amplification. Learners could adapt and refine designs already evaluated.

ACTIVITY 4

Learners could use design software (CAD) to design a suitable printed circuit board (PCB) layout which could be manufactured, constructed and tested. The performance of the final working circuit could be evaluated through experimentation. Improvements to the circuit design and construction could be considered and/or implemented. The final design could be used to augment a IET Formula 24+ electric car.

MODULE 5



COMMERCIAL VEHICLE ELECTRONICS AND MANUFACTURE

Link to qualification: http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

The project concludes with Unit 5 (LO3 and LO5), Unit 6 (LO5) and Unit 7 (LO1, LO2 and LO4).

Learners will consider the design and development of commercial vehicles, including hybrid and electric vehicles, in terms of:

- layout of electrical and electronic systems
- application of embedded systems including programmable devices
- commercial circuit manufacture
- use of sensors and actuators
- the application of smart and modern materials.

Contained within the following assessment criteria/LO(s)/units:

Learning Outcome	LO number	Unit number
Be able to apply a systems approach to electrical design	LO3	Unit 5
Understand the application of programmable process devices in electronic design	LO5	Unit 5
Understand commercial circuit manufacture	LO5	Unit 6
Understand semiconductor and programmable devices	LO1	Unit 7
Understand electrical sensors and actuators	LO2	Unit 7
Understand the application of smart and modern materials in electrical devices	LO4	Unit 7

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

PRACTICE REVIEW ACTIVITIES FOR MODULE 5

ACTIVITY 1

Learners could investigate other electrical and electronic systems used within commercial electric vehicles. This could be extended to include hybrid and combustion engine vehicles. Systems to investigate could include: engine management, powertrain, car safety and stability, driver information and convenience or infotainment.

System manufacturer websites might prove a useful starting point e.g. http://w3.siemens.com/powerdistribution/global/EN/lv/green-applications/electromobility/Pages/electromobility.aspx

Learners could develop system diagrams showing layout, including systems using embedded programmable devices (e.g. http://www.ti.com/lit/ml/szza058c/szza058c.pdf?DCMP=Automotive_in&HQS=hybrid-in)

ACTIVITY 2

Learners could investigate commercial manufacturing techniques used in the production of vehicles. This could include the use of multi-layer printed circuit boards, manufacturing and quality assurance processes for electrical/electronic systems and electrical/electronic component protection from the elements. It could also include how programmable devices are used within systems that manufacture vehicles.

ACTIVITY 3

Learners could explore the use of sensors and actuators in the vehicle – highlighting sensors that capture a range of parameters such as position, speed, flow, temperature, light and pressure. Actuators controlling both rotary and linear movement should also be investigated.

This could be for vehicles with combustion engines, hybrid vehicles and/or battery electric vehicles.

ACTIVITY 4

Learners could investigate the use of smart and modern materials in automobile design – highlighting their application and reasons for their use. This could include production cars and/or concept cars (e.g. http://smartforvision.basf.com/)

OTHER RESOURCES

Below is a list of resources available from the OCR website which can support the delivery of this project.

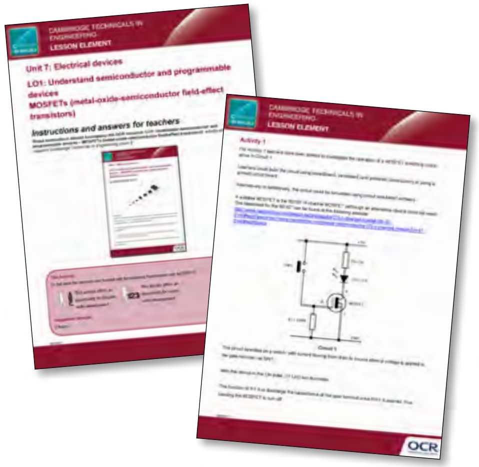
http://www.ocr.org.uk/qualifications/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

Delivery Guides

Delivery Guides contains suggestions for activities for lessons. There is a Delivery Guide for each unit, structured by learning outcome so that you can see how each activity helps learners cover the unit. We've also included links to other resources you might find useful

Lesson Elements

There are three Lesson Elements for each unit. Each one is a fully worked up lesson activities with teacher instructions and answer along with learner task sheets.



Resources Links

Resources Links provide a range of other resources you might find useful – videos, data sets and other online content. As well as producing a Resources Links for each unit, we've also produced a Resources Links specifically for the Project Approach.

Skills Guides

We have produced a range of skills guides covering a variety of topics, including research, communication skills, managing projects, problem solving.

www.ocr.org.uk/i-want-to/skills-guides/

OPPORTUNITIES FOR HOLISTIC DELIVERY OF OTHER UNITS

Examples of further units from Cambridge Technicals in Engineering that could be integrated holistically into this Project Approach include those listed below. Examples of how they might be integrated are included.

This Project Approach may also be used to support the delivery of other units in the qualification.

Unit	LO	How the units/LOs in this table could be integrated into the teaching of this Project Approach (Units 5, 6, 7, 8)
Unit 1 Mathematics for engineering	LO1	Develop simple transfer functions for elements of the electric car control system e.g. sensors and actuators
	LO3	Determine angular rotation of electric motor and car wheels
Unit 2 Science for engineering	LO1	Determine errors in the control system i.e. measured and actual values
	LO2	Represent speed and velocity of the electric car using graphical methods
	LO2	Calculate force, work and energy in order to determine car efficiency
	LO4	Understand the properties and limitations of the materials used for the electric car construction
Unit 3 Principles of mechanical engineering	LO1	Calculate moments and torque in the rotating parts of the electric car
	LO2	Determine speed, velocity, acceleration and distance travelled
	LO3	Apply levers, gears or belts to the car
	LO4	Evaluate materials properties for construction of the car
Unit 4 Principles of electrical and electronic engineering	LO1	Calculate electrical power and energy used by the electric motor
	LO3	understand the principle of operation of any motors or generators used in the car
	LO5	Understand the use of analogue elements in circuit design e.g. sensors with analogue outputs
	LO6	Understand digital aspects used in circuit design, including Boolean operations
Unit 9 Mechanical design	LO1	Produce engineering drawings for the electric car
	LO2	Select and justify materials for the car
	LO3	Design components for the car
	LO4	Produce am optimised design to improve car performance
Unit 10 Computer Aided Design (CAD)	LO1/LO2	Produce 3D CAD models of the car or its components
	LO3	Produce 2D engineering drawings of the car
Unit 11 Materials science	LO2	Evaluate failure modes of components used on the car
	LO3	Understand processing techniques used on parts of the car
	LO4	Apply smart and modern materials to car construction
Unit 12 Mechanical simulation and modelling	LO1	Simulate moving assemblies used in the car
	LO2	Perform a finite element analysis (FEA) of aspects of the car design
	LO4	Evaluate the aerodynamics of the car using computational fluid dynamics (CFD)

Unit	LO	How the units/LOs in this table could be integrated into the teaching of this Project Approach (Units 5, 6, 7, 8)
Unit 13 Mechanical operations	LO1	Produce production plans and carry out risk assessments for practical activities
	LO2	Use hand tools and processes to manufacture the car
	LO3	Use a lathe to manufacture car components
	LO4	Use a milling machine and drill to manufacture car components
	LO5	Quality assure components manufactured for the car
Unit 22 Engineering and the environment	LO1	Understand the importance of sustainability in engineering
	LO2	Understand the advantages of using renewable technologies (e.g. electric vehicles)
	LO5	Know how innovations are making a difference to the way in which engineering interacts with the environment

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

If you do not currently offer this OCR qualification but would like to do so, please complete the Expression of Interest Form which can be found here: www.ocr.org.uk/expression-of-interest

OCR Resources: *the small print*
OCR's resources are provided to support the teaching of OCR specifications, but in no way constitute an endorsed teaching method that is required by the Board and the decision to use them lies with the individual teacher. Whilst every effort is made to ensure the accuracy of the content, OCR cannot be held responsible for any errors or omissions within these resources. We update our resources on a regular basis, so please check the OCR website to ensure you have the most up to date version.

© OCR 2015 – This resource may be freely copied and distributed, as long as the OCR logo and this message remain intact and OCR is acknowledged as the originator of this work.

OCR acknowledges the use of the following content:
Square down and Square up: alexwhite/Shutterstock.com

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications:

We will inform centres about any changes to the specification. We will also publish changes on our website. The latest version of our specification will always be the one on our website (www.ocr.org.uk) and this may differ from printed versions.

Copyright © OCR 2015. All rights reserved.

Copyright
OCR retains the copyright on all its publications, including the specifications. However, registered centres for OCR are permitted to copy material from this specification booklet for their own internal use.

ocr.org.uk/engineering

OCR customer contact centre

Vocational qualifications

Telephone 02476 851509
Facsimile 02476 851633
Email vocational.qualifications@ocr.org.uk

OCR is part of Cambridge Assessment, a department of the University of Cambridge. *For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.* © **OCR 2015** Oxford Cambridge and RSA Examinations is a Company Limited by Guarantee. Registered in England.
Registered office 1 Hills Road, Cambridge CB1 2EU. Registered company number 3484466. OCR is an exempt charity.

A DIVISION OF CAMBRIDGE ASSESSMENT

LLOYD'S REGISTER • LRQA
ISO 9001

UKAS MANAGEMENT SYSTEMS
001