MCAST

MQF Level 5

MV5-A1-22

# Undergraduate Diploma
# in
# Auto Electronic and Electrical Technology

## Course Specification

# Course Description

The course is intended for qualified automotive technicians seeking to broaden their knowledge on Electric Vehicles and Hybrids. Students start from the fundamentals and concepts of electrical and electronic systems. Subsequently they are then gradually introduced to the advanced theory of Auto electrical and electronic control systems and microprocessor control systems. The course delves into the theory of Electrical Vehicles and Hybrids, including electrical machines, power electronics, and the different energy sources available on the market. The course also provides hands-on experience using diagnostic approaches that help students troubleshoot potential integration problems. Learners are also instructed to work with various electronics equipment and become familiar with various computer-controlled systems, diagnostic software test equipment and tooling.

# Programme Learning Outcomes

At the end of the programme the learner is able to:

1. *Service and maintain Electric and Hybrid Vehicles.*
2. *Be familiar with the fundamentals and concepts of Electrical and Electronics Systems.*
3. *Be aware of the H&S requirements, and the use of tooling when working on an EV or Hybrid.*
4. *Differentiate between various EV control systems and various Energy Sources.*
5. *Possess excellent knowledge on Microprocessor systems, power sources and Electrical machines.*

# Entry Requirements

Any MCAST MQF Level 4 Certificate in Electrical, Electronics or Automotive Engineering

OR

2 A-Level passes and 2 I-Level passes

Compulsory A-Level or I-Level: Physics

# Other Entry Requirements

All applicants are asked to sit for a Medical Test in view of any Colour Blindness

# Current Approved Programme Structure

| Unit Code | Unit Title | ECTS |
|---|---|---|
| ETE&E-506-2100 | Fundamentals and Concepts of Electrical and Electronic Systems | 6 |
| ETH&S-503-2100 | Health and Safety in Electrical Vehicle and Hybrid Maintenance | 3 |
| ETAUT-506-2100 | Auto Electrical Systems | 6 |
| ETENG-506-1901 | Mathematics for Engineers | 6 |
| ETAUT-503-2101 | Use of Tooling for Electrical Vehicle and Hybrid Maintenance. | 3 |
| ETAUT-506-2102 | Microprocessor Systems and Auto Electronic Control Systems | 6 |
| **Undergraduate Certificate in Auto Electronic & Electrical Technology** | | **30 credits** |
| ETAUT-506-2103 | Electrical Vehicles and Hybrids | 6 |
| ETAUT-506-2104 | Electrical Machines | 6 |
| ETAUT-506-2105 | Power Electronics | 6 |
| ETAUT-506-2106 | Energy Sources | 6 |
| ETAUT-506-2107 | Control Systems for Hybrid and Electrical Vehicles | 6 |
| **Undergraduate Diploma in Auto Electronic & Electrical Technology** | | **60 credits** |

# Unit: ETE&E-506-2100 Fundamentals and Concepts of Electrical and Electronic Systems

**Unit level (MQF):** **5**

**Credits:** **6**

## Unit description

The scope of this unit is to present learners with the fundamental principles of Electrical and Electronic technology which are present in every system. Learners need to be conversant with different circuit analysis techniques in order to understand how circuits operate. After circuit analysis, learners are exposed to the operating principles of a range of electronic devices both passive and active.

A number of fundamental circuits are presented and analysed. Using typical circuits learners are introduced to the simulation process which allows circuit parameters to be modified before actual construction. A range of construction techniques are presented. Since most processing today is done in the digital domain via microprocessors or custom digital hardware learners are introduced to the concepts of digital circuits. Both combinational logic which consists of logic gates and building blocks and sequential circuits and techniques are covered.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Apply circuit theory to solve problems*
2. *Appraise the operations of Electronic devices*
3. *Evaluate the operation of Electronic Circuits*
4. *Investigate the fundamentals of digital circuits*

# Unit: ETH&S-503-2100 Health and Safety in Electrical Vehicle and Hybrid Maintenance

**Unit level (MQF):** 5

**Credits:** 3

## Unit description

The scope of this unit is to present learners with the fundamentals of health and safety within an electric/hybrid vehicle workshop. Risk assessment and management for both AC and DC electrical supplies is presented with a clear identification of the ranges of voltages and currents which can cause harm or injury.

Personal protective equipment required for carrying out electromechanical tasks are studied in detail within the context of an alternative vehicle workshop. The assessment of the electrical installation of the workshop including protection devices are also studied for the electric vehicle technician to be aware of technical and legal requirements.

A learning outcome is dedicated to the fire safety within the workshop, where the learner is presented with basic fire training, fire classes, fire extinguisher and handling of fire situations. Learners will also carry practical tasks such as designating safe working zones and fire assembly zones. The environmental impact, storage and disposal of hazardous media such as lithium battery cells, fuel cells and hydrogen/methane gas is also to be investigated.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Understand the health and safety risks associated with Electric/Hybrid Vehicles.*
2. *Identify the required Personal Protective Equipment for Working with Electric/Hybrid Vehicles.*
3. *Understand the fundamentals of fire safety in the workshop.*
4. *Understand the fundamentals of hazardous material storage and disposal in the Electric/Hybrid Vehicle industry.*

# Unit: ETAUT-506-2100 Auto Electrical Systems

**Unit level (MQF):** 5

**Credits:** 6

## Unit description

The need for economical vehicles together with restrictions on NOx emissions to continue improving the impact of millions of vehicles on the environment, necessitated immense efforts to develop new engine designs. Gasoline direct injection helped reduce emissions and brought about a fuel savings of about 20%.

The scope of this unit is to present learners with knowledge on modern petrol and diesel engines' electrical systems.

In this unit learners will familiarize themselves with petrol engine management concepts that include Cylinder Charge Control, fuel injection systems, various ignition systems and catalytic emissions control systems.

As for diesel engines, the call for lower fuel consumption, reduced gas emissions and quiet engines made greater demands on diesel engine designs and their control systems. In view of this, learners will get a comprehensive insight into today's diesel engines with an emphasis on modern diesel injection systems and their electronic control units, and how they minimize emissions through exhaust gas treatment.

The unit will delve into how modern petrol and diesel engines managed to reduce the Nox emissions to the present levels through their innovative designs and through the application of complex electronic control algorithms such as closed loop control.

A thorough explanation on the function of different sensors and actuators found in both diesel and petrol engines will be given, highlighting the contribution they give to a better engine performance in terms of reduced emissions and better torque generation.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Describe the principle function of Motoric Engine-Management and Electronic Diesel Control.*
2. *Demonstrate the function of Lighting Technology, Electronic Stability and Occupant Protection.*
3. *Explain the function of Networking in Automobiles.*
4. *Identify the different kind of sensors installed in auto vehicles.*

# Unit: ETENG-506-1901 Mathematics for Engineers

**Unit level (MQF):** **5**

**Credits:** **6**

## Unit description

Learners reading for an Engineering degree require a solid mathematical knowledge in order to be able to deal with new technologies and challenges. Further, numerical methods are essential tools for any engineer, since not every engineering situation can be solved using analytical methods. Indeed, such is the computational power today that it is more worth it to solve problems using numerical methods even if they can be solved analytically.

This unit is designed to provide students with the required working knowledge, skills and competencies for furthering their studies on engineering pre-degree and degree courses. This study unit covers the use of number systems, arithmetic algebra, solving polynomials, indices, logarithms, series, use of simultaneous equations and partial fractions. Additionally, it gives the opportunity for learners to investigate curve fitting and various geometric properties.

This study unit also covers trigonometric identities and functions. Additionally, it allows students to apply the standard differential coefficients, basic principles of integration. The aim of this module is thus to allow learners revise their mathematical skills and bridge the gap to the necessary level in the subject, thus preparing them for use it in engineering practice.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Apply algebraic relationships and topics to solve and manipulate expressions.*
2. *Use graphical methods to investigate and solve the geometric properties of various curves and surfaces.*
3. *Apply trigonometric identities and functions.*
4. *Apply standard differentiation and integration techniques to solve problems.*
5. *Compute limits of sequences and convergence and approximate sums of series.*

# Unit: ETAUT-503-2101 Use of Tooling for Electrical Vehicle and Hybrid Maintenance

**Unit level (MQF):** **5**

**Credits:** **3**

## Unit description

The scope of this unit is to present learners with the fundamental knowledge of tools and test equipment required for maintaining electric/hybrid vehicles. The unit introduces a variety of general-purpose hand tools along with specialized equipment required to work on the voltage ratings associated with alternative vehicles.

A wide range of electrical and electronic testing instruments are reviewed and practical demonstrations are carried out as required. The learners should have sufficient knowledge to carry out the required maintenance routines and also assess whether the work environment is electrically safe to the necessary standards.

Learners will also be introduced to the preparation and implementation of maintenance plans related to alternative vehicle maintenance. Students will also be trained in reading and the representation information in the form of schematics and diagrams.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Use hand tools for electrical vehicle maintenance.*
2. *Use electrical test equipment for electrical vehicle maintenance.*
3. *Use electronic test equipment for electrical vehicle maintenance.*
4. *Evaluate electrical vehicle performance through a test plan.*

# Unit: ETAUT-506-2102 Microprocessor Systems and Auto Electronic Control Systems

**Unit level (MQF):** 5

**Credits:** 6

## Unit description

The scope of this unit is to present learners with knowledge of digital electronics, starting from the very basic concepts and progressing to microprocessor systems. The idea is to show the learner how to build electronic systems so that the learner will be able to trouble-shoot similar systems found in real automobiles.

In this unit, learners will be familiarizing themselves with the most popular numbering systems used in computer technology, binary logic, logic gates, sequential circuits and microprocessors.

The unit will start by showing learners how to use logic gates to build simple control systems with an emphasis on automobile applications such as automatic control of headlamps, alarms systems, turbo timers, etc.

The unit will then delve into microprocessor technology with an emphasis on building embedded systems using microcontrollers to control actuators such as Fan motors, idle speed control valves, servo motors, head lamps, wiper motors, window winders, etc.

The unit will also show the learner how to interface with various sensors used in automobiles such as temperature sensors, rain sensors, light sensors, pressure sensors, etc.

The above is accompanied by a step by step guide on using C language to make embedded systems more intelligent.

Ultimately, the learner will be taught trouble-shooting techniques using instruments such as Digital Multimeters and Oscilloscopes on their own embedded systems.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Apply the basics of Numbering Systems and Binary Arithmetic.*
2. *Use the C language for programming.*
3. *Design an embedded system for the automotive.*
4. *Troubleshoot a microprocessor/microcontroller based system.*

# Unit: ETAUT-506-2103 Electrical Vehicles and Hybrids

**Unit level (MQF):** 5

**Credits:** 6

## Unit description

The scope of this unit is to present learners with the fundamental knowledge of electric and hybrid vehicle drivetrain configurations. The differences between traditional and electric-based vehicles will be outlined with an analysis of each technology based on various factors such as cost, emissions and complexity.

The unit also aims to introduce the learner to calculations related to traction and storage requirements through a problem-based approach. These calculations are to be verified through modelling and simulation and validated under different conditions. This unit is to partly complement the energy storage technologies studied in the unit Energy Sources.

An important aspect which is to be studied is that of energy management within electric and hybrid vehicles. Different classes of energy management strategies are to be reviewed and compared. Implementation challenges of such energy management strategies are also to be discussed.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Understand the fundamentals of Electric and Hybrid Vehicle Drivetrains.*
2. *Evaluate electric traction and energy storage for Electric Vehicles.*
3. *Model and Simulate systems within Electric or Hybrid Vehicles.*
4. *Understand the fundamentals of Energy Management Strategies.*

# Unit: ETAUT-506-2104 Electrical Machines

**Unit level (MQF):** 5

**Credits:** 6

## Unit description

The scope of this unit is to present learners with the fundamental knowledge of electrical machine theory and operation. Electrical machines are found in a wide range of applications and are essential to modern electric vehicles. Electrical machines provide both traction and peripheral operations.

In this unit, learners will be presented with the most basic electromagnetic theory principles which are essential to understand the operation of electrical machines. The concept of an electrical machine is to be introduced through studying the DC brushed machine which was the first machine to be developed and is still used in several low to medium power applications. The construction and operation of the DC brushed machine is to be then compared to that of brushless machines.

Brushless AC machines have superseded the DC brushed machine in most medium to high-power applications and are popular as traction machines in electric and hybrid vehicles. In this unit, learners will study the construction and operation of various brushless machines including Induction Machines, Permanent Magnet Synchronous Machines and DC Brushless Machines. A review of the differences between each of these Brushless Machines is also to be carried out within this unit. The unit also provides an overview of the state-of-the-art Reluctance Machine of the Switched and Synchronous type. The advantages of reluctance-based motors are to be studied with respect to other types of brushless machines.

The unit shall provide the opportunity to the learners to understand the theoretical principles of the different electrical machines while offering a good perspective of practical work carried out on these machines. The unit complements the power electronic circuits studied in the unit Power Electronics.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Understand the fundamentals of Electromagnetism.*
2. *Evaluate the operation of Brushed DC Machines.*
3. *Evaluate the operation of Brushless AC Machines.*
4. *Understand the fundamentals of Reluctance Machines.*

# Unit: ETAUT-506-2105 Power Electronics

**Unit level (MQF):** 5

**Credits:** 6

## Unit description

The scope of this unit is to present learners with the fundamental knowledge of power electronic devices and circuits. Power electronics are found in a wide range of applications and are the fundamental building blocks of modern electric vehicles. Power electronics are essential for both the charging circuits and driving the electrical traction machines in such vehicles.

In this unit, learners will be presented with the most commonly used power electronic devices of both discrete and integrated form. These devices are used to build common circuits such as AC-DC, DC-DC and DC-AC converters. The AC-DC circuits to be studied are required to convert from a grid-connected AC supply to a DC voltage, which serves as a feed-in for both DC-DC and DC-AC converters. Various AC-DC rectifier topologies will be studied including single-phase and three-phase with both uncontrolled and controlled semiconductor devices. DC-DC converters form the basis of controlled charging circuits within electric vehicles and therefore will also be studied within this context. DC-AC topologies such as inverters are the main drive components for the effective operation of electrical machines within an electric vehicle. Three-phase inverters are to be highlighted within the course since these circuits are the most used in modern electric vehicles.

The unit aims for the student to evaluate the operation of power electronic circuits both analytically and experimentally. Throughout the course, the students should also familiarize with test equipment and good practices which are specially used in power electronics and drives.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Understand the fundamentals of Power Semiconductor Devices.*
2. *Evaluate the operation of AC-DC Converters.*
3. *Evaluate the operation of DC-DC Converters.*
4. *Evaluate the operation of DC-AC Converters.*

# Unit: ETAUT-506-2106 Energy Sources

**Unit level (MQF):** 5

**Credits:** 6

## Unit description

The scope of this unit is to present learners with the fundamental knowledge of energy sources storage devices within the context of electric vehicles. Energy storage in electric vehicles does not only provide a source for traction but it also contributes significantly to the integration of electric vehicles within the smart grid.

In this unit, learners will be familiarized with a wide variety of energy storage technologies which are used for starting purposes (found in combustion, hybrid and electric drive trains) and for traction (hybrid and electric vehicles). The unit also presents the basic quantities and calculations required for battery sizing and life cycles. The unit covers the most used battery technologies including the traditional lead-acid and nickel-based. Furthermore, an in-depth analysis of more modern lithium-based batteries is to be carried out. Alternative state-of-art energy storage and recovery mechanisms such as super-capacitors and flywheels are also presented.

The unit also reviews battery health and lifetime and the advantages of having dedicated peripheral hardware such as Battery Management Systems (BMS) and Battery Thermal Management (BTM). Learners should be encouraged to further research the latest energy storage systems as part of their course.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Understand the fundamentals of Lead-Acid and Nickel-based Battery Technology.*
2. *Understand the fundamentals of Lithium-based Battery Technology.*
3. *Understand the fundamentals of Alternative Energy Storage Devices.*
4. *Evaluate Management Systems as applied to Energy Storage within Electric Vehicles.*

# Unit: ETAUT-506-2107 Control Systems for Hybrid and Electrical Vehicles

**Unit level (MQF):** 5

**Credits:** 6

## Unit description

The scope of this unit is to present learners with the fundamental knowledge of control systems within the context of alternative vehicles. Learners are introduced to Control System Terminology, Differential Equations in Linear Systems and Laplace Transformations. This is intended to provide a background in basic control theory which is then to be used within the electric vehicle context. The unit is to contain both theoretical and practical exercises to highlight the relevance of control systems within modern electrical-based transportation.

As part of the unit, the learners are to carry out several practical control tasks to demonstrate competence in applying principles learnt in previous units within a practical context. Students should be encouraged through a practical assignment to design simple firmware/hardware solutions to achieve given control tasks. Various practical applications are to be considered including motor control, battery charging and regenerative braking.

## Learning Outcomes

**On completion of this unit the student should be able to:**

1. *Understand the fundamentals of Control System Terminology.*
2. *Understand the fundamentals of Differential Equations in Linear System.*
3. *Apply Laplace transformations to Linear Systems.*
4. *Understand the applications of control theory in alternative vehicles.*