Course Name: **Professional Certificate: Servicing and Repairing Hybrid & Electric Vehicles – A Practical Approach**

Contact Hours: 27

Pre-requisite: Basic Automotive Knowledge

Abstract

This course will equip individuals with theoretical knowledge and practical skills required to service Hybrid Electric Vehicles (HEV) or Electric Vehicles (EV). Basic electrical and electronic concepts will be included to cater for those persons who lack knowledge in this area. The course combines theory and hands on applications using test instruments and stripped down HEV/EV vehicle components. Emphasis will be placed on safety in working with HEV/EV.

Participants will be prepared to pursue the following professional certifications from the Institute of Motor Industries (IMI UK) in Electric and Hybrid Electric Vehicle:

- IMI International L1 Award in Electric/Hybrid Vehicle Awareness
- IMI International L2 Award in Electric/Hybrid Vehicle Routine Maintenance Activities

Target Audience

This course is geared towards persons who plan to work and interact with electric and hybrid electric vehicles at various levels and will prepare them to function in different positions.

Level 1 (Non- technical roles)

These persons can obtain the IMI Level 1 Award via an online knowledge based assessment.

- Managers
- Valeters
- Parts advisors
- Sales and aftersales advisor
- Vehicle recovery personnel
- Vehicle dismantlers
- Vehicle damage assessors
- Electric/Hybrid professional drivers

Level 2 (Routine Maintenance Technicians)
These persons can obtain the IMI Level 2 Award via both online knowledge based assessment and a practical hands on assessment.

- Person who will be engaged in EV/HEV maintenance and repair technicians
- First Responders

Learning Outcomes

On completion of this course, learners will be able to:

1. *Understand how hybrid vehicles operate*
2. *Learn how to work safely around hybrid & electric vehicles*
3. *Understand electrical/electronics and how it applies to HEV/EV vehicles*
4. *Understand the high voltage powertrain operation*
5. *Understand how the HEV brake system functions*
6. *Safely remove, repair and replace high voltage battery packs*
7. *Perform hybrid preventive maintenance and service*

Course Content

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1. **HEV/EV Technology**

   What is a hybrid and different types of hybrids: HEV, PHEV (Plug-in Hybrid Electric Vehicle), EV; A look at the Toyota Prius and other type of Hybrids; Overview of Hybrid parts. Alternative fuel source vehicle types.

2. **Safety Requirements Associated with HEV/EV**

   PPE: High Voltage Safety; Safety Equipment , Safety Gloves, Safety Mats, Insulated Tools; Multimeters and Insulations testers. Cabling and color coding

   Circuit Protection: Fuse, thermal cut outs, insulation

3. **HEV/EV Electrical and Electronics**

Electrical Terminology and symbols: Voltage, Current, Power, Resistance and their units, Insulators and conductors, Ohms Law, Difference between DC and AC Circuits; Single Phase and Three Phase Automotive Electronic Components: diodes, transistors, relays, transformers, High voltage definition in HEV/EV.

Motors: electromagnetic induction, permanent magnet type, brush and brushless, power rating output, armature and rotor, winding and stator, Continuity, open and short circuit. Charger and charging points, ignition /key-on control switch, driver display panel, multi-battery server unit, heating and air conditioning system components.

4. **High Voltage Powertrain Operation**

Planetary Gears Set Basics, Toyota CVT, Service and Maintenance, Coolants;
Electric Motors and their Operation with and without planetary gear set; Inverter/converter assembly purpose and operation; DC-DC converter purpose and operation; Inverter/Converter cooling system importance; how to service Inverter/Converter cooling system.

5. **HEV/EV Braking Systems**

ABS systems used in Hybrids; Operation of Regenerative Brakes; Safety Issues; Brake Fluids; Brake pedal stroke sensor; Brake light switch importance.

6. **Hybrid Batteries, 12V and HV Battery systems**

Types of Batteries used in HEV/EV vehicles; 12V Batteries; HV battery pack construction; HV battery State of Charge (SOC); Module, Stick, V Block, Safety, Battery safe down procedure; Contactors/relay identification, operation and testing; Battery pack testing, removal and repair; High Voltage Battery cooling systems. Battery Management Interface, Operational temperature range, housing: materials used, Charging process,

7. **Hybrid Preventive Maintenance: Service and Repair**

Names of parts; Antifreeze Use In Transmission; Safety Issues in Servicing HEV; Oil Change Issue; Maintenance Procedures; Test Instruments Used: SCAN Tools for Hybrids; Jump Starting; Proper Towing; Perform Safety Shutdowns; Check High Voltage Battery State of Charge (SOC) Using Scan Tool; Test High Voltage Battery With Special Test Equipment.

Perform Fluid Changes, Perform Coolant Flush of CVT, Remove And Replace CVT. Test Stators of Electric Motors. Conduct Brake Work, Remove and Replace Brake Components, Remove and replace High v Batteries Safely, Diagnose a No-Start Hybrid, Remove and Replace HV Contactors, Operate Test Instruments Correctly

Assessment Criteria

In order to achieve Learning Outcome…	The Learner must…
1. Hybrid/EV Technology	1.1 Explain what is a HEV /EV and their differences 1.2 Distinguish between HEV and PHEV 1.3 Explain the operation of HEV systems parts and operation 1.4 Identify alternative fuel source vehicles
2. Safety Requirements Associated with Hybrid and Electric Vehicles	2.1 Be able to operate / correctly test equipment and tools safely for high voltage systems on HEV/EV 2.2 Understand the procedure for testing and working around Batteries Packs 2.3 Demonstrate the safe use of HV Safety Gloves in servicing HEV/EV 2.4 Carry out safe isolation of the high energy electrical system , following the vehicle manufacturer's instruction 2.5 Use the safe method to reinstate the vehicle following the manufacturer's instruction using the correct tools 2.6 State the hazards that may be present in the event of an accident or suspected overcharging 2.7 Identify potential hazards when making connections for charging electric vehicles. 2.8 Describe how to identify high energy cabling and associated components 2.9 Describe how the vehicle may be safely charged using an external source 2.10 State the levels of current and voltage that present a hazard to humans for both alternating and direct current systems 2.11 Describe the methods that vehicle manufacturers use to provide protection from high energy electrical cabling and components

3. HEV Electrical and Electronics	3.1 Understand the relationship between Voltage, Current, Resistance and Power in DC and AC circuits 3.2 Understand The difference between Single Phase and Three Phase 3.3 Understand basic electrical and electronic components like resistors, diodes, transistor, capacitors, relays and their use in automotive electronics 3.4 Understand the concept of grounding 3.5 Explain the construction and operation of an induction AC motor 3.6 Understand the correct use of Electrical test instrument 3.7 Give examples of the typical voltages used for a range of electric vehicles
4. High Voltage Powertrain System and Operation	4.1 Understand the operation and function of electric motors in HEV Transmissions 4.2 Explain how Planetary Gears work in a Toyota HEV 4.3 Be able to remove and replace a CVT 4.4 Be able to Perform Coolant and Transmission Flush of a Toyota CVT 4.5 Explain Inverter/ Converter operation 4.6 Test inverter/ converter, remove and replace parts. 4.7 Be able to test Stator of AC motors of HEV using Milli-Ohm tester 4.8 Be able to perform insulation test on High voltage cables 4.9 Explain the what is a resolver and its function in the HEV/EV 4.10 Explain the importance of inverter/converter cooling system 4.11 Perform Inverter/Converter cooling system flush
5. Hybrid Electric Vehicle/ Electric Vehicle Braking Systems	5.1 Understand ABS in Hybrid Vehicle 5.2 Explain the concept of Regenerative braking and its use in the charging process in HEV 5.3 Be able to remove and replace braking component in a HEV and conduct other brake work for service

	5.4 Be able to explain the role and function of the brake switch, the brake pedal stroke sensor.
6. Hybrid Batteries, 12v and HV Battery systems.	6.1 Be able to distinguish between the different types of Batteries used in HEV/EV 6.2 Understand the role and function of the 12v Battery. 6.3 Be able to explain HV Battery contactor/ relay operation and testing 6.4 Be able to explain the charging process of the batteries including equalization 6.5 Be able to remove and replace Battery packs 6.6 Be able to test Batteries and system voltages 6.7 Be able to conduct SOC test on Battery 6.8 Packs using Scan Tools 6.9 Be able to follow procedures to shut down electrical systems in HEV 6.10 Understand battery cooling systems
7. Hybrid Preventive Maintenance: Service and Repair	7.1 Be able to correctly use a SCAN tool for testing and diagnosing HEV problems 7.2 Conduct Battery Pack service 7.3 Be able to correctly used insulated hand tools when working on HEV/EV 7.4 Be able to correctly use CAT III rated meters to test for high voltages 7.5 Be able to correctly use Insulation Tester for testing 7.6 Be able to perform test for an open and a short circuit 7.7 Perform service on CVT 7.8 Servicing HVAC systems of HEV/EV vehicle. 7.9 Select and use suitable source of technical information to support electric /hybrid vehicle maintenance and repair activities. 7.10 Use the correct procedure to connect and alternative power source to an electric / hybrid vehicle (high or low voltage system)

Learning Resources:

Learners will be provided with slides, publications, data sheets, supporting videos and websites.

Facilitators:
Mr. Adrian Lyons
Mr. Brian Ramkissoon

Website: https://www.theimi.org.uk/