Unit 10: Operation and Testing of Vehicle Electronic Ignition Systems

NQF Level 3: **BTEC National**

Guided learning hours: 60

Unit abstract

Electronic ignition systems have developed in line with the advancement of engine technology and engine management systems. Modern electronic ignition systems have improved vehicle reliability, performance and efficiency of operation. Recent advances in spark plug design, manufacture, operation and longer working life have also improved electronic ignition systems.

It is important that all motor vehicle technicians are aware of these systems and are able to recognise and confirm faults. This unit will enable learners to understand the fundamental operating principles of electronic ignition systems and will give them the knowledge and understanding needed for accurate diagnosis and repair. Learners will develop an understanding of the main components and their relationship to the efficient operation of the engine unit and sub-systems.

Learning outcomes

On completion of this unit a learner should:

1 Know about the function and operation of conventional ignition system components

2 Understand the operation of programmed electronic ignition and distributor less ignition systems

3 Know about the function and operation of pulse generators and control modules

4 Be able to undertake tests on electronic ignition system to verify system faults.

Unit content

1 **Know about the function and operation of conventional ignition system components**

Ignition system components: circuits (diagrams, primary, secondary); contact breaker; coil; leads; distributor and cap; rotor arm; spark plugs; mechanisms (mechanical advance, retard, vacuum advance)

Ignition system functions: ignition timing (static and dynamic); dwell (angle, time, variation); ignition scope patterns eg spark Kv, primary circuit, secondary circuit, dwell, coil output

2 **Understand the operation of programmed electronic ignition and distributor less ignition systems**

Programmed electronic ignition: components, functions and operation; electronic control unit; sensors eg manifold absolute pressure, crankshaft, camshaft, engine temperature, knock, air temperature; ignition coil; distributor; ignition switch; reluctor disc; discharge eg capacitor, inductive

Distributor less ignition system: components, functions and operation; transformer; capacitor; ignition coil(s) eg waste spark, direct acting; spark plug; sensor eg manifold pressure, crankshaft, camshaft, knock; primary current switching modules, waste spark, direct acting

3 **Know about the function and operation of pulse generators and control modules**

Generators: Hall effect eg Hall voltage, Hall IC, vanes, magnet, control module; inductive pick-up eg permanent magnet, inductive windings, trigger wheel; optical pulse eg light emitting diode, phototransistor

Transistor assisted contacts: transistor operation; Darlington amplifier; advantages of breaker less systems

Control modules: eg pulse shaping, dwell period control, voltage stabilisation, primary switching, pulse processing, secondary output control, ignition amplifier, air gap, electronic spark advance, spark advance map, read-only memory (ROM), erasable programmable read-only memory (EPROM), knock control

4 **Be able to undertake tests on electronic ignition system to verify system faults**

Test components/circuits for satisfactory operation: equipment eg on-board diagnostics, test instruments, voltage drop tester, electronic control unit tester; spark advance and retard tester; safe working practice; components and circuits eg fuses, wiring, connectors, coil, spark plug, leads, rotor arm, distributor cap, pulse generator, sensors (such as crankshaft, camshaft, knock), break out box, ignition switch, reluctor air gap; checking for faults eg moisture, dirt, corrosion, fault code reading, gap, data link connection, output and resistance, spark plug leads condition and resistance, rotor arm condition and leakage, distributor cap condition and leakage, dwell angle, spark plug condition, pulse generator module resistance, ignition timing, sensor output, sensor operation

Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describes the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that the learner is able to:**	**To achieve a distinction grade the evidence must show that the learner is able to:**
P1 explain, with the aid of appropriate diagrams, the function of the main components and the operation of a typical conventional ignition system P2 distinguish between dwell angle, dwell time and dwell variation P3 explain the functions of the main components and the operation of a programmed electronic ignition system P4 explain the functions of the main components and the operation of a distributor less ignition system P5 describe the Hall effect, the operation of an inductive pick-up module and an optical pulse generator	M1 compare the relative advantages and disadvantages of a typical conventional ignition system, a programmed electronic ignition and a distributor less ignition system M2 suggest methods for dealing with typical faults on the electronic ignition system.	D1 explain how the conventional ignition system, programmed electronic ignition and distributor less ignition system operate in a variety of cold start and acceleration situations D2 analyse test results to diagnose defects, wear and maladjustment in the ignition system from given data and symptoms.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that the learner is able to:**	**To achieve a distinction grade the evidence must show that the learner is able to:**
P6 describe the advantages of a breaker less system when used within transistor operation and a Darlington amplifier P7 describe the use of two control modules P8 use appropriate equipment to carry out basic tests on five components/circuits to verify faults in an ignition system.		

Essential guidance for tutors

Delivery

Delivery of this unit should ensure that learners have a thorough understanding of conventional and electronic ignition system components and their interrelationship with each other. A balance of theoretical and practical study is recommended and systems and operating principles should be demonstrated using rigs, units and components.

Safe working practices should be followed in any practical activities, which should also reflect current commercial practice within learners' vocational areas.

The learning outcomes are ordered in a logical way and could therefore be delivered sequentially. Learning outcome 4 requires practical investigation and as such learners will need the underpinning knowledge and understanding obtained through studying learning outcomes 1, 2 and 3 beforehand.

Note that the use of 'eg' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'eg' needs to be taught or assessed.

Assessment

Assessment of this unit will normally be carried out through a combination of assignments, projects, and practical investigations. The unit can be linked to other units such as *Unit 5: Applications of Vehicle Science and Mathematics* and *Unit 6: Vehicle Electrical and Electronic Principles* and it would be appropriate, where possible, to combine assessments. Alternatively this unit could be assessed using four assignments.

The first assignment could assess P1 and P2, with written tasks for each criterion. For P1 the use of diagrams is essential in the assessment process, and learners should explain both the function and operation of the main components of a typical conventional ignition system. This should include the type of circuit, contact breaker, coil, leads, distributor and cap and rotor arm. For P2 a simple description including the differences between the indicated elements could be assessed at the same time.

A second assignment could cover P3, P4, P5, P6 and M1. This could also provide an opportunity to direct learners to D1. Separate written tasks could be given for each criterion and the responses are likely to be in the format of a report.

P7 could be assessed independently in a third assignment, or could be linked to the second assignment.

A final assignment covering P8, M2 and D2 could be assessed with the aid of task sheets that track authenticated, reliable and current practical activities on five components/circuits. The structure of this assignment is critical and tutors should ensure that there are opportunities to diagnose faults (P8), suggest methods for dealing with faults (M2), and analyse test results on defects, wear and maladjustment (D2). The data and symptoms should be given to each learner. The evidence provided must include the test results involved and would typically incorporate printouts from test equipment. A witness statement/observation record would be a suitable form of evidence to show what the learner did and the equipment they used when carrying out tests.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit supports the following units in the Level 3 Automotive Skills National Occupational Standards for Vehicle Maintenance and Repair:

- Unit MR 01: Carry out Routine Vehicle Maintenance
- Unit MR 05: Conduct Pre and Post Work Vehicle Inspections
- Unit AE 04: Diagnose and Rectify Engine Electrical Faults.

The unit can also be linked to other BTEC units such as *Unit 5: Applications of Vehicle Science and Mathematics* and *Unit 6: Vehicle Electrical and Electronic Principles*.

Essential resources

Learners will need access to vehicle workshops equipped with modern vehicles, rigs, components and appropriate test equipment.

Indicative reading for learners

Bosch R — *Automotive Electrics/Automotive Electronics* (Professional Engineering Publishing, 2004) ISBN 1860584365

Hillier V A — *Fundamentals of Automotive Electronics* (Nelson Thornes, 1996) ISBN 0748726950

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• explaining functions and operation of ignition systems • describing the Hall effect, operation of an inductive pick up module and an optical pulse generator • describing the use of control modules • writing up results of testing for faults.	C3.2 Read and synthesise information from at least **two** documents about the same subject. Each document must be a minimum of 1000 words long. C3.3 Write **two** different types of documents each one giving different information about complex subjects. One document must be at least 1000 words long.
Problem solving level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• using appropriate equipment to carry out basic tests on five components/circuits • verifying test results.	PS3.1 Explore a problem and identify different ways of tackling it. PS3.2 Plan and implement at least one way of solving the problem.