

# **Criteria for the Diploma Qualifications in Engineering at Levels 1, 2 and 3**



September 2011

Ofqual/11/5052

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## **The criteria**

### **Introduction**

1. The purpose of this document is to record a full set of criteria for principal learning for the Diploma in Engineering at foundation, higher and advanced levels. It also sets out the aims for the overall Diploma in Engineering.
2. This document should be read in conjunction with the Ofqual document *Criteria for Foundation, Higher and Advanced Diploma Qualifications*.

### **Themes**

#### **Theme A: The engineered world**

3. The purpose of this theme is to stimulate and encourage learners to pursue a career in engineering by challenging misconceptions and demonstrating that engineering is a worthwhile and exciting career choice. It will give learners an understanding of the 'made world' and the impact that technology and manufacturing have on people's everyday lives.

#### **Theme B: Discovering engineering technology**

4. The purpose of this theme is to encourage learners to discover, through simple practical investigation, the fundamental engineering principles and to promote their curiosity as to the nature of engineered products and systems. Learners will be able to investigate simple manufacturing and maintenance techniques using conventional tools and equipment which form the basis of engineering. They will understand the basics of engineering communication. To set engineering in a 21st-century context, investigations will be supported by the use of computer-aided engineering to manufacture products.

#### **Theme C: Engineering the future**

5. The purpose of this theme is to introduce the learner to new engineering technologies and to encourage them to be imaginative when thinking about the ways in which engineering will be used in the future. It will also provide learners with an understanding of the impact of engineering on the wider world and prospects for the future.

**Theme D: Analytical methods for engineering**

6. This theme provides learners with the knowledge, skills and understanding of mathematical and scientific principles used by engineers in analysis, design and problem solving.

**Structure**

<b>Structure of Diplomas in Engineering</b>			
<i>Level</i>	<i>Foundation</i>	<i>Higher</i>	<i>Advanced</i>
Total guided learning hours (GLH)	600	800	1,080
Principal learning (GLH)	240	420	540
Generic learning (GLH)	240	200	180
Additional/specialist learning	120	180	360

**Foundation level structure**

**Summary of topic titles**

<b>Topic no.</b>	<b>Title</b>	<b>GLH</b>
	Theme A: The engineered world	
1.1	Introducing the world of engineering	30
	Theme B: Discovering engineering technology	
1.2	Practical engineering and communication skills	60
1.3	Using computer-aided engineering	30
1.4	Routine maintenance operations	30
1.5	Introduction to engineering materials	30

1.6	Introduction to electronics	30
	Theme C: Engineering the future	
1.7	Engineering the future	30

## **Theme A: The engineering world**

### **Topic 1.1: Introducing the world of engineering (30 GLH)**

#### *Purpose*

7. Learners will have the opportunity to understand why engineering is important to the social and economic development of the world we live in and the benefits produced by technological advancement. To ensure a balanced view, the topic also introduces the concepts of sustainability and accountability and the requirement for the engineering industry to operate in a way which is in harmony with the wellbeing of planet earth.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the sectors of engineering and the types of jobs available in the industry;
- the contribution engineering makes to the social and economic development of the world we live in;
- the impact of sustainability, green issues and legislation on the way that the engineering industry operates.

Learners will develop skills in:

- effective participation in teamwork;
- research and investigation;
- presentation and communication.

## **Theme B: Discovering engineering technology**

### **Topic 1.2: Practical engineering and communication skills (60 GLH)**

#### *Purpose*

8. This topic provides the learner with the opportunity to understand the principles which will allow them to work safely in an engineering workshop environment. It is a practical topic which introduces the learner to basic manufacturing and assembly techniques, using simple hand tools and other manufacturing equipment. They will be able to produce and use simple engineering drawings and diagrams to communicate and inform.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- health and safety issues relating to self and colleagues;
- the cutting, forming and joining processes used when producing engineered products;
- the techniques used to assemble and disassemble products;
- drawing techniques used to communicate technical information.

Learners will develop skills in:

- selecting tools and equipment;
- using tools safely and effectively;
- cutting, forming and joining;
- assembling and disassembling engineered products;
- producing and interpreting drawings that adhere to sector standards.

### **Topic 1.3: Using computer-aided engineering (30 GLH)**

#### *Purpose*

9. This topic provides the learner with the opportunity to investigate the use of computer software packages and systems in the design and manufacture of engineering components. It is a practical topic with the learner being given the opportunity to design and manufacture a simple component that is machined in two dimensions.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- how computer software packages are used to design products;
- how computer software packages are used to control the operation of machine tools;
- how the design and manufacture of products can be integrated under the banner of computer-aided engineering.

Learners will develop skills in:

- producing engineering component drawings using a Computer-Aided Drawing (CAD) system;
- producing circuit diagrams using a CAD system;
- using a Computer-Aided Manufacturing (CAM) software package to convert an engineering drawing of a component into a programme that can be used to operate a machine tool;
- setting up a computer-controlled machine tool to manufacture a simple engineered product.

#### **Topic 1.4: Routine maintenance operations (30 GLH)**

##### *Purpose*

10. Learners will have the opportunity to understand how equipment and systems are maintained so that they operate correctly to specification. It is a practically focused topic which introduces the learner to basic maintenance routines that require the use of simple hand tools, measuring equipment, product information and reporting documentation.

##### *Scope of content*

Learners will develop knowledge and understanding of:

- the types of maintenance procedures carried out in industry;
- health and safety issues relating to self and colleagues;
- the documentation used when planning and carrying out maintenance of engineered products and services.

Learners will develop skills in:

- selecting tools and equipment;
- using tools safely and effectively;
- assembling and disassembling engineered products;
- extracting information from drawings and manuals;
- carrying out routine maintenance to schedule;
- making measurements using inspection equipment;
- investigating causes of failure;
- keeping maintenance records.

## **Topic 1.5: Introduction to engineering materials (30 GLH)**

### *Purpose*

11. This topic provides the learner with the opportunity to understand why it is necessary to specify the correct type of material to enable a product to be manufactured. It is a practically focused topic which introduces the learner to the basic test and research procedures that need to be performed when identifying commonly used engineering materials.

### *Scope of content*

Learners will develop knowledge and understanding of:

- the types of material that engineers use;
- the basic properties of engineering materials;
- the forming processes applicable to particular materials;
- how an engineering designer decides which material to use for a particular application.

Learners will develop skills in:

- using simple test equipment to identify materials;
- using basic test procedures to evaluate the mechanical properties of materials;
- identifying the materials from which a product has been made;
- specifying materials for particular applications;
- research and investigation;
- presentation and communication.

## **Topic 1.6: Introduction to electronics (30 GLH)**

### *Purpose*

12. This topic provides the learner with the opportunity to understand how prototype electronic circuits are constructed in an engineering laboratory environment. It is a practically focused topic which introduces the learner to undertake basic identification and assembly techniques working with circuit diagrams, hand tools and test equipment.

### *Scope of content*

Learners will develop knowledge and understanding of:

- standard symbols used to represent electronic components;
- working with circuit diagrams;
- planning the construction of electronic circuits;
- how electronic circuits are tested.

Learners will develop skills in:

- interpreting circuit diagrams;
- identifying and selecting electronic components and materials;
- selecting tools and equipment;
- correctly using tools to construct circuits;
- selecting and using test equipment.

## **Theme C: Engineering the future**

### **Topic 1.7: Engineering the future (30 GLH)**

#### *Purpose*

13. This topic provides the learner with the opportunity to understand the importance of developing new materials and technologies for use in the 21st century and beyond. It is set in the context of how technological change and advancement affects the way in which products are designed, manufactured and used.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- developments in materials and engineering technology that impact on everyday life;
- how products are recycled or safely disposed of at the end of their useful life;
- renewable energy sources and environmental issues.

Learners will develop skills in:

- effective participation in teamwork;
- research and investigation;
- presentation and communication.

## **Higher level structure**

### **Summary of topic titles**

<b>Topic no.</b>	<b>Title</b>	<b>GLH</b>
	Theme A: The engineered world	
2.1	The engineered world	60
	Theme B: Discovering engineering technology	
2.2	Engineering design	60
2.3	Engineering applications of computers	60
2.4	Producing engineering solutions	60
2.5	Construct electronic and electrical systems	30
2.6	Manufacturing engineering	60
2.7	Maintenance	30
	Theme C: Engineering the future	
2.8	Innovation, enterprise and technological advance	60

## **Theme A: The engineered world**

### **Topic 2.1: The engineered world (60 GLH)**

#### *Purpose*

14. Through investigation into significant engineering achievements since the 19th century, this topic provides learners with the opportunity to develop an understanding of the contribution that engineering makes to the social and economic development of the world. The topic also requires learners to develop an understanding of the engineering sectors, their diversity, and their products and services. Learners will also develop an understanding of career pathways in engineering, the responsibilities and duties between employers and employees, and the way in which engineering has impacted on their everyday lives.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the sectors of engineering and their products and services;
- the career and training opportunities, job roles, career paths and the role of professional bodies in engineering;
- the contribution of 19th-, 20th- and 21st-century engineering achievements to social and economic development;
- the rights and responsibilities of employers and employees in engineering.

Learners will also develop skills in:

- effective participation and teamwork;
- self-management and independent enquiry;
- research, investigation and analysis;
- presentation and communication.

## **Theme B: Discovering engineering technology**

### **Topic 2.2: Engineering design (60 GLH)**

#### *Purpose*

15. This topic provides learners with the opportunity to understand the importance of engineering design through the study of engineering products and components. The learner will produce a product design specification for a given design brief. For a chosen product design specification they will produce and present a design solution using appropriate presentation methods.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the importance in the performance/functions of an engineering product;
- key requirements of design briefs;
- key considerations influencing product design specifications;
- implications of standards and legislation;
- techniques for producing design ideas and solutions;
- proving a design;
- presentation techniques for presenting design solutions;
- scientific, mathematical and materials knowledge that underpin designing.

Learners will develop skills in:

- analytical and problem solving;
- communications;

- practical engineering for dismantling products;
- presentation.

### **Topic 2.3: Engineering applications of computers (60 GLH)**

#### *Purpose*

16. This topic provides learners with the opportunity to learn about and experience the use of computers in a range of engineering applications, including problem solving, diagnostics, process control and manufacturing. The topic also enables a learner to understand how computers have enabled advances in the way engineering tasks are performed.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the use of computers in process control and manufacturing;
- the use of microprocessor controllers in domestic products;
- the use of computers in maintenance operations.

Learners will develop skills in:

- simple expert systems for problem solving in engineering;
- computer-based communication systems to communicate data;
- simple control programmes.

## **Topic 2.4: Producing engineering solutions (60 GLH)**

### *Purpose*

17. The purpose of this practical topic is to allow learners the opportunity to learn about and have experiences of producing engineering solutions. These activities can be carried out in the context of production, maintenance, installation and commissioning. The activities will range from the use of engineering drawing and the selecting of suitable materials, parts and components, to using processes, tools and equipment safely and effectively.

### *Scope of content*

Learners will develop knowledge and understanding of:

- properties of materials;
- standard components;
- health and safety and standards;
- production planning of a single item.

Learners will also develop skills in:

- using processes, tools and equipment safely and effectively;
- performing quality checks.

## **Topic 2.5: Construct electronic and electrical systems (30 GLH)**

### *Purpose*

18. This topic provides learners with the opportunity to learn about the basic principles and techniques used in the construction of electronic and electrical systems. This is a practical topic which complements the topic on engineering design and enables the learner to develop further understanding of the importance of applied mathematical skills in engineering.

*Scope of content*

Learners will develop knowledge and understanding of:

- basic electrical and electronic principles;
- recognising and selecting components;
- the operating principles of circuits;
- testing and fault finding.

Learners will also develop skills in:

- using circuit diagrams;
- electronic and electrical circuits;
- tools and equipment safety;
- performing simple calculations.

**Topic 2.6: Manufacturing engineering (60 GLH)**

*Purpose*

19. This topic will enable the learner to understand and have experience of the decisions and processes of multiple production. It is a practical topic which allows the learner to replicate the methods used to produce a component or system on a quantity production basis, as well as use processes, tools and equipment safely and effectively.

*Scope of content*

Learners will develop knowledge and understanding of:

- performing quality checks;
- the use of computer-controlled machines;
- multiple production processes;
- planning for multiple production;

- the importance of health and safety in an industrial workplace.

Learners will also develop skills in:

- test and measurement equipment;
- applying statistical methods to testing;
- programming and setting up machines;
- working in teams.

### **Topic 2.7: Maintenance 30 GLH**

#### *Purpose*

20. This topic will provide learners with the practical opportunity to experience the basic principles and techniques of engineering maintenance. Learners will be expected to carry out different types of maintenance procedures for products and services. Learners will also experience using manufacturers' information in carrying out maintenance and diagnostic procedures, and learn to work safely. They will acquire an understanding of the implications of poor maintenance and learn about preventative maintenance.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- different types of maintenance processes;
- interpreting manufacturers' information and data sheets;
- the use of statistical methods for analysing failure trends;
- the implications for the user and the manufacturer if products or equipment are not properly maintained.

Learners will also develop skills in:

- using equipment safely and effectively;
- correct maintenance of equipment;
- following manufacturers' guidance in carrying out maintenance tasks and diagnostic routines;
- presenting and interpreting data;
- devising maintenance procedures. Theme C: Engineering the future

### **Topic 2.8: Innovation, enterprise and technological advance (60 GLH)**

#### *Purpose*

21. This topic provides learners with opportunities to learn about the development of new ideas and the methods to ensure that innovative ideas are protected. Learners will explore the ways in which engineering businesses benefit and profit from new innovations. Learners will also develop an understanding of new technologies and the effects of technological change on the home, businesses, the economy and society.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- how innovation and creativity benefit engineering;
- the role of research and development when designing and developing products;
- methods used to protect new ideas;
- raising finance;
- impact of new developments in materials and new processes on products;
- the environmental and social impact of engineering and sustainability of resources;
- the effects of engineering technologies in the home, workplace and built environment.

Learners will also develop skills in problem solving and innovative thinking, as well as investigative and evaluative skills.

## **Advanced level structure**

### **Summary of topic titles**

<b>Topic no.</b>	<b>Title</b>	<b>GLH</b>
	Theme A: The engineered world	
3.1a	Engineering businesses and career pathways	60
	Theme B: Discovering engineering technology	
3.1b	Engineering and the environment	
3.2	Applications of computer-aided designing	60
3.3	Selection and application of engineering materials	60
3.4	Instrumentation and control engineering	60
3.5	Maintaining engineering systems and products	30
3.6	Production and manufacturing	60
	Theme C: Engineering the future	
3.7	Innovative design and enterprise	60
	Theme D: Analytical methods for engineering	
3.8	Mathematical techniques and applications for engineers	60
3.9	Scientific principles and applications for engineers	90

## **Theme A: The engineered world**

### **Topic 3.1a: Engineering businesses and career pathways (30 GLH)**

#### *Purpose*

22. This topic provides the learner with the opportunity to understand how engineering businesses operate, their processes and the internal and external factors that affect the business. The topic also develops an understanding of the importance of working as a competent employee, and the need for registration and regulation within engineering industries.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the organisation of engineering businesses and the influence of internal and external factors;
- the career pathways in engineering and the need for regulation;
- the role of project management and contractual arrangements;
- legislation in engineering business;
- the importance and function of risk assessment.

Learners will develop skills in:

- working in a team – taking responsibility for decisions that affect others;
- analytical thinking, including making the business case;
- simple risk assessments;
- time and project management.

Topic 1a will be combined with Topic 1b into a single topic: Engineering businesses and the environment.

## **Theme B: Discovering engineering technology**

### **Topic 3.1b: Engineering and the environment (30 GLH)**

#### *Purpose*

23. This topic provides opportunities to learn about clean manufacturing, including the sources of environmental pollution and the engineering methods used to control them. Learners will also learn about the costs of manufacturing in terms of minimising waste and rework, and the sustainability of resources and processes. Learners will apply mathematical methods to analyse engineering processes and environmental data to provide evidence about the effects of industry and urbanisation.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the problem of resource depletion;
- pollution control, preventing both air and water contamination;
- management to reduce environmental effects of solid and hazardous waste,;
- waste water and changes in the environment;
- managing changes in the environment;
- water supply and land management methods;
- solutions such as maximising the use of renewable resources, minimising waste products and clean manufacturing.

Learners will develop skills in:

- research;
- data collection;
- applying mathematics to chemical processes and data analysis;

- collecting environmental samples;
- simple chemical analysis.

Topic 1b will be combined with Topic 1a into a single topic: Engineering businesses and the environment.

### **Topic 3.2: Applications of computer-aided designing (60 GLH)**

#### *Purpose*

24. This topic will enable learners to acquire skills, knowledge and understanding of the role of computer-aided design in engineering. Learners will gain knowledge of how computers and software packages are used for modelling and to provide data for a variety of engineering purposes, including design, testing and manufacturing planning.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the use of 2D and 3D software;
- drawing to industrial standards;
- designing for manufacture;
- computer systems and data storage;
- the integration of CAD into combined design/manufacturing systems;
- the use of concurrent engineering systems.

Learners will develop skills in using software packages for:

- designing;
- modelling;
- testing and stimulating design ideas;

- producing drawings to specified standards;
- producing and modifying presentation drawings.

### **Topic 3.3: Selection and application of engineering materials (60 GLH)**

#### *Purpose*

25. This topic will enable learners to find out about the structure, properties and classification of engineering materials. Learners will apply their understanding of properties of materials, design, cost and availability to correctly specify materials for different engineering applications. Learners will also develop an understanding of the key features and applications of new and smart materials. Learners will investigate what causes materials to deteriorate and how this can be prevented. Learners will also learn how to use mathematical and scientific principles within engineering metallurgy.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- atomic structures, amount of bonding, periodicity and classification of engineering materials;
- mechanical and thermal properties and durability of materials;
- destructive and non-destructive testing methods;
- effects of processing on structure and behaviour of materials;
- factors of safety and modes of failure of engineering materials;
- the standard forms in which materials are supplied;
- using information sources to select materials for engineering applications;
- key features of new and smart materials, and their potential applications.

Learners will develop skills in:

- laboratory methods of testing engineering materials;
- data analysing;
- applied scientific principles;
- analytical thinking and problem solving;
- safe use of equipment.

### **Topic 3.4: Instrumentation and control engineering (60 GLH)**

#### *Purpose*

26. This practical topic provides opportunities to learn about and apply the underpinning theory and principal components in instrumentation and control engineering. Learners will also learn how to use mathematical principles in the design and implementation of a simple control system. The topic will develop an understanding of instrumentation and control applications in industry, and the impact of instrumentation and control applications upon the environment and everyday life.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- signals and wave guides;
- open loop, closed loop, feed-forward and feedback control theory;
- data communications and multiplexers;
- sensors and transducers;
- AD/DA converters, operational amplifiers, PID controllers and PLCs;
- actuators and instrumentation displays;
- industrial and domestic applications of control engineering.

Learners will develop skills in:

- applied mathematics;
- selecting and using electronic components;
- using simulation software;
- designing analogue and digital systems.

### **Topic 3.5: Maintaining engineering systems and products (30 GLH)**

#### *Purpose*

27. This topic will enable learners to understand about the maintenance of engineering systems and products. Through this study, learners will develop an understanding of the importance of planned maintenance in terms of efficiency, cost and impact on the environment, loss in production or use of product.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- the consequences of plant and equipment failure;
- cost analysis of poor maintenance;
- effective maintenance strategies;
- planning a maintenance activity;
- closed loop engineering systems;
- risk assessment;
- probability;
- application of statistics;
- work and energy.

Learners will develop skills in:

- analysing data to determine effective maintenance strategies;
- planning a maintenance regime;
- planning and carrying out a maintenance activity.

### **Topic 3.6: Production and manufacturing 60 GLH**

#### *Purpose*

28. Learners will have the opportunity to look at the types and methods of engineering production and manufacturing, and to develop the knowledge and understanding of different manufacturing processes, assembly systems and techniques. Learners will also learn about different manufacturing systems. These will include, for example, mass production, lean manufacturing, flexible manufacturing and just-in-time systems. Learners will apply their understanding of manufacturing and production systems and develop a production plan, taking into consideration all the influencing factors, including implications of quality control and quality assurance.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- different types of manufacturing processes;
- CAE, CAM and CNC;
- assembly systems and techniques;
- the wide ranging manufacturing/production systems used within engineering industries;
- production planning considerations;
- quality control and quality assurance requirements in manufacturing and production, including statistical process control.

Learners will develop skills in:

- analytical thinking and problem solving;
- communication and computer skills;
- production planning;
- project planning/scheduling.

## **Theme C: Engineering the future**

### **Topic 3.7: Innovative design and enterprise (60 GLH)**

#### *Purpose*

29. This topic will enable learners to understand about innovative design, the use of new technologies and successful engineering entrepreneurs. Through this study they will develop knowledge and understanding of engineering design and enterprise.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- innovative engineering designs and new technologies;
- the commercial issues of developing, marketing and selling a new product or idea;
- successful engineering entrepreneurs;
- the environmental and social impact of engineering and sustainability of resources used;
- designing for the environment.

Learners will develop skills in:

- design thinking and problem solving;
- analytical thinking and using data;
- identifying opportunities for technological or commercial advantage;
- protecting ideas and copyright legislation

## **Theme D: Analytical methods for engineering**

### **Topic 3.8: Mathematical techniques and applications for engineers (60 GLH)**

#### *Purpose*

30. This topic will enable learners to develop knowledge and understanding of mathematical methods used by engineers in analysis, design and problem solving. Learners will develop an understanding of the applications of geometry, trigonometry, algebra and calculus in real engineering situations.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- trigonometric identities and equations for statics and dynamics, electrical laws, power factor correction, signals, phasors;
- geometry, coordinate systems, vectors;
- algebra, quadratic equations, indices, binomial expansion, partial fractions;
- calculus, differentiation, integration, maxima and minima, rates of change;
- exponential decay, applications in mechanics;
- mathematical modelling, moments and centres of mass, kinematics, Newton's law of motion;

- statistics, data analysis;
- work, energy, friction and machines.

Learners will develop skills in:

- mathematical applications;
- using mathematical modelling and mathematical techniques;
- identifying mathematical solutions to real-world problems.

### **Topic 3.9: Scientific principles and applications for engineers (90 GLH)**

#### *Purpose*

31. This topic will enable learners to develop knowledge and understanding of the scientific principles used by engineers in analysis, design and problem solving. Learners will study and develop understanding of the applications of electrical, physical, chemical and thermodynamic laws and fluid mechanics used in real engineering situations.

#### *Scope of content*

Learners will develop knowledge and understanding of:

- electrical properties of solids, resistance and resistivity, dielectric constants and capacitance, basic device characteristics, electric fields, electromagnetic induction, Ohm's law, Kirchhoff's law, Lenz's law, Lorentz force; semiconductors;
- mechanics, statics and structures, kinematics, laws of motion;
- thermodynamics, expansion and compression of gases, heat of combustion and changes in state;
- inorganic chemical reactions, oxidation and reduction, pH, exothermic and endothermic reactions, metallurgical principles;
- organic chemistry, Friedel Crafts reaction, alkylation of benzene;
- hydrostatic systems, fluids in motion, aerodynamics;

- radiation, particles, sound, light and waves.

Learners will develop skills in:

- applying knowledge to real engineering systems;
- analysis and problem solving;
- application of mathematical methods;
- use of computers and simulations;
- constructing and recording scientific experiments.

### Level 1 groups/pathways

Group/ pathway	Specialist areas	Purpose
Energy and utilities	Utilities engineering	Learners will be introduced to the engineering processes used in gas, water and electricity distribution and waste management systems, and the procedures used in the installation and maintenance of utilities services, including water treatment and distribution, gas distribution, electricity generation and distribution and waste management.
	Energy sources and systems	Learners will be introduced to energy sources, energy conservation and energy uses. The learner will study the basic scientific principles of energy sources and their applications, energy generation and distribution systems, investigate the ways energy is wasted or lost, and conduct a simple energy audit of a building and its sources of renewable energy.
Science, engineering and manufacturing technology	Aerospace engineering	Learners will be introduced to the world of aerospace engineering, covering how the industry operates and what it makes, including the design, production, testing and maintenance of the key products of the sector,

		<p>such as aircraft, helicopters, spacecraft, satellites, spacecraft launch vehicles, dirigibles and gliders. It will cover the features of the industry and the basic engineering processes used in the sector, such as key design principles and manufacturing techniques of parts and accessories, such as wings, turbo-jets and propellers, landing gear, motors and aero engines, and the manufacture of aircraft launching gear and simulators.</p>
	<p>Automotive engineering</p>	<p>Learners will be introduced to the world of automotive engineering, covering how the industry operates and what it makes, including the design, production, testing and maintenance of the key products of the sector, such as cars, commercial vehicles, buses and coaches, and the manufacture of parts and accessories for motor vehicles, and bodies (coachwork) for motor vehicles.</p>
	<p>Electrical engineering</p>	<p>Learners will be introduced to electrical engineering as a fundamental concept in engineering and its application in the real world, covering how the</p>

		<p>industry operates and what it makes, including the design, production, testing and maintenance of the key products of the sector, such as electric motors, generators and transformers, switches and circuit construction, electricity distribution and control apparatus, insulated wire and cable, accumulators, primary cells and primary batteries, lighting equipment and electric lamps, and electrical equipment for signalling and transport safety,</p>
	<p>Electronic engineering</p>	<p>Learners will be introduced to electrical engineering as a fundamental engineering concept and industry in its own right, underpinning all other engineering industries and processes. This will include examples of its application across electronic instrumentation and process control equipment, medical, precision and optical instruments, watches and clocks, electronic components including semiconductors, navigational devices, office machinery and computers, telecommunications technology, manufacture of electronic components,</p>

		including semiconductors, consumer electronics, computers and other IT equipment.
	Marine engineering	Learners will be introduced to the world of marine engineering, covering how the industry operates and what it makes, including the design, production, testing and maintenance of the key products of the sector such as ships, tankers, ferry boats and fishing vessels, pleasure and sporting boats, including sailboats and inflatables, marine engines and the construction of hovercraft, drilling platforms and pontoons.
	Mechanical engineering	Learners will be introduced to mechanical engineering as a fundamental engineering concept, including its uses and applications, how the industry operates and what it makes, including the design, production, testing and maintenance of the key products of the sector, such as machinery used in a range of industries, including food and drink, mining, textile production, agriculture, earthmoving and forestry, engines and turbines, industrial and domestic machinery,

		equipment and appliances, and weapons and ammunition.
	Bio-engineering	Learners will be introduced to bio-engineering, covering how science relates to engineering and where scientific exploration through engineering is contributing to improved standards of living. It will cover pharmaceutical manufacturing, bioscience for the processing and production of materials, the application of bioscience to produce innovative medicines and therapeutics, sports engineering applications, natural sciences research and experimental engineering.
Passenger transport	Transport engineering	Learners will be introduced to engineering within the context of transport, including vehicle servicing, repairs and basic/routine maintenance activities. Learners will have opportunities to learn broadly about aspects of transport engineering and its relevance in everyday life.
Automotive	Foundation vehicle maintenance	Learners will be introduced to routine vehicle maintenance. Learners must demonstrate routine maintenance tasks and complete a periodic

		maintenance and pre-sales inspection.
	Foundation fitting and repair	Learners will be introduced to fitting and repair. Learners must identify structural and non-structural damage, repair a vehicle panel and remove and refit a body part.
	Foundation body and repair	Learners will be introduced to body and paint techniques. Learners must identify the correct procedures for painting preparation and applying a top coat to a panel.
	Foundation vehicle electrical systems	Learners will be introduced to electrical principles within vehicles. Learners will demonstrate the removal, test and refit of electrical components.
Building services engineering	Building services engineering	Learners will be introduced to building services engineering and the range of carrier pathways within this sector (air conditioning and refrigeration, electrical installation, heating and ventilation, plumbing).

## Level 2 groups/pathways

Group/ pathway	Specialist areas	Purpose
Energy and utilities	Utilities engineering	Learners will have opportunities to develop their understanding of the gas, water and electricity distribution and waste management systems, and the engineering procedures used in their installation and maintenance, including surveying and use surveying equipment, and the procedures used in construction of surface and underground distribution systems.
	Renewable energy sources	Learners will have opportunities to develop knowledge of renewable energy systems and energy conservation. The learner will study the function and applications of solar heat energy and photovoltaic, wind and hydropower systems, the uses of bio-fuels and their methods of production, and justify a renewable energy system application for a building or transport system.
Science engineering and manufacturing technology	Aerospace engineering	Learners will be introduced to the world of aerospace engineering, covering how the industry operates, what it produces and the engineering process of design, manufacture, testing, research and maintenance

		<p>of aircraft, helicopters, spacecraft, satellites, spacecraft launch vehicles, dirigibles and gliders. Learners will have opportunities to develop and apply their knowledge and understanding of the features of the industry, how it works and the basic engineering processes used in the sector, such as manufacture of parts and accessories, such as wings, turbo-jets and propellers, landing gear, motors and aero engines, and the manufacture of aircraft launching gear and simulators.</p>
	<p>Automotive engineering</p>	<p>Learners will be introduced to the world of automotive engineering, covering how the industry operates, what it produces and the engineering process of design, manufacture, testing, research and maintenance. Learners will have opportunities to develop and apply their knowledge and understanding of engineering manufacturing processes of cars, commercial vehicles, buses and coaches, and the manufacture of parts and accessories for motor vehicles and bodies (coachwork) for motor vehicles.</p>

	<p>Electrical engineering</p>	<p>Learners will be introduced to electrical engineering as a fundamental concept and its application in the real world. Learners will have opportunities to develop and apply their knowledge and understanding of the design, manufacture, testing, research and maintenance of electric motors, generators and transformers, electricity distribution and control apparatus, insulated wire and cable, accumulators, primary cells and primary batteries, lighting equipment and electric lamps and electrical equipment for signalling and transport safety etc.</p>
	<p>Electronic engineering</p>	<p>Learners will be introduced to electronic engineering as a fundamental engineering concept and industry in its own right, underpinning all other engineering industries and processes. Learners will have opportunities to develop and apply their knowledge and understanding of its application across electronic instrumentation and process control equipment, medical, precision and optical instruments, watches and clocks, electronic components, including</p>

		semiconductors, navigational devices, office machinery and computers, telecommunications technology, manufacture of electronic components including semiconductors, consumer electronics, computers and other IT equipment.
	Marine engineering	Learners will be introduced to the world of marine engineering, covering how the industry operates, what it produces and the engineering process of design, manufacture, testing, research and maintenance. Learners will have opportunities to develop and apply their knowledge and understanding of the design, building, maintenance and repair of ships, tankers, ferry boats and fishing vessels, building and repair of pleasure and sporting boats including sailboats and inflatables, the manufacture and maintenance of marine engines and the construction of hovercraft, drilling platforms and pontoons.
	Mechanical engineering	Learners will be introduced to mechanical engineering as a fundamental engineering

		<p>concept. Learners will have opportunities to develop and apply their knowledge and understanding of its uses and applications in the process of design, manufacture, testing, research and maintenance of machinery used in industries such as food and drink, mining, textile production, agriculture, earthmoving and forestry, engines and turbines, industrial and domestic machinery, equipment and appliances, and weapons and ammunition.</p>
	<p>Bio-engineering</p>	<p>Learners will be introduced to bio-engineering giving them opportunities to develop and apply their knowledge and understanding of how science relates to engineering, and where scientific exploration through engineering is contributing to improved standards of living. It will cover pharmaceutical manufacturing, bioscience for the processing and production of materials, the application of bioscience to produce innovative medicines and therapeutics, sports engineering applications, natural sciences research and experimental engineering.</p>

	<p>Mathematical applications in engineering</p>	<p>Learners will develop the underpinning mathematical knowledge to solve engineering problems. Learners will be given the opportunity to integrate and apply mathematical concepts to a minimum of two engineering areas, which could cover transportation (land, air, sea or space), manufacturing, energy generation/processing, engineering systems, electrical/electronics engineering, mechanical engineering, process engineering, maintenance engineering.</p>
	<p>Business improvement techniques</p>	<p>Learners will be introduced to the world of business enterprise and the importance of applying business improvement techniques to the engineering sector. Learners will be given opportunities to develop and apply their knowledge and understanding of the factors that impact on business success, strategies to improve the performance of a business, the key economic features of engineering and technology development, and the key engineering processes and their impact on the success of an engineering business.</p>

*Criteria for the Diploma Qualifications in Engineering at Levels 1, 2 and 3*

<p>Passenger transport</p>	<p>Engineering and maintenance in the bus and coach industries</p>	<p>Learners will develop an understanding of engineering and maintenance in the bus/coach industries, including vehicle servicing, repairs, routine maintenance activities and basic tools and materials. They will learn how new technology is impacting on the maintenance and engineering roles in the industry, and the impact of environmental awareness.</p>
	<p>Engineering and maintenance in the rail industry</p>	<p>Learners will develop an understanding of engineering and maintenance in the rail industries, including vehicle servicing, repairs, routine maintenance activities and basic tools and materials. They will learn how new technology impacts on maintenance and engineering roles in the industry, the relationships between engineering and other key parts of the rail industry, and the impact of environmental awareness.</p>
	<p>Providing customer service</p>	<p>Learners will develop an understanding of the importance of customer service to the transport sector and the importance of good communication with customers, including communicating technical information to internal/external</p>

		customers. Learners will learn about different types of internal customers within the transport sector, the importance of a professional customer service approach and the ways that customer service is reviewed.
Chemical, nuclear oil and gas, petroleum and polymer industries	Petroleum technology The process industry Process chemistry Processing fluids Processing solids Chemistry for petroleum operators	Learners will be able to explore in detail various aspects of the gas extraction, chemicals manufacturing and petroleum industries to broaden and deepen their learning.
Automotive	Intermediate motor vehicle principles	Learners will understand how safety and comfort features of vehicles are linked to cost and maintenance, including the forces on a vehicle in motion, and will describe and evaluate the safety aspects of a vehicle's structure and design features that contribute to comfort. Through this the learner will understand the links between design, cost, safety and servicing.
	Intermediate vehicle maintenance	Learners will build on the principles of maintenance delivered in the principal learning in the context of vehicles. Learners will develop skills in demonstrating routine maintenance and be able to complete maintenance records.

	Intermediate fitting and repair	Learners will be introduced to vehicle repair and will be expected to use tools, equipment and measuring instruments for fitting and repair. Learners will demonstrate the removal and replacement of vehicle components.
	Intermediate body and paint	Learners will be introduced to vehicle body and paint repair principles, including the safe use of tools and equipment in the preparation and application of materials, and will prepare for and apply foundation materials and topcoats.
	Intermediate motorsports	Learners will be introduced to motorsports maintenance. Learners will understand vehicle preparation for and during a motorsport event.
	Intermediate electrical and electronic systems	Learners will build on the principles of electrical and electronic systems delivered in the principal learning in the context of vehicles. Learners will apply their knowledge of the nature and laws of electricity and magnetism, and understand the principles of solid state devices used in electrical and electronic circuits.
Building services engineering	Building services engineering	Learners will develop knowledge, skills and understanding and develop relevant skills in

		building services engineering, and the range of occupations and careers available within the sector.
	Plumbing operations	Learners will develop knowledge, skills and understanding, and develop relevant skills in, plumbing systems, their operational features and characteristics.
	Refrigeration and air-conditioning operations	Learners will develop knowledge, skills and understanding, and develop relevant skills in, refrigeration and air conditioning (RAC) operations, RAC systems, their operational features and characteristics.
	Electrical installation operations	Learners will develop knowledge, skills and understanding, and develop relevant skills in, electrical installation systems, their operational features and characteristics.
	Heating and ventilating operations	Learners will develop knowledge, skills and understanding, and develop relevant skills in, heating and ventilating systems, their operational features and characteristics.

### Level 3 groups/pathways

Group/pathway	Specialist areas	Purpose
Energy and utilities	Energy and utilities supply	Learners will have opportunities to develop their knowledge of utilities engineering, including the installation and maintenance of utilities services, the procedures used in the location, detection and inspection of utilities services, the use of trenchless technologies in the installation, replacement and repair of underground supplies, and the regulatory framework and health and safety legislation relating to the provision of overhead and underground utilities supplies.
	Renewable energy	Learners will have opportunities to develop an understanding of renewable energy sources, their technical and social issues and energy conservation. The learner will study the scientific principles of renewable energy sources and their applications, including solar and photovoltaic, wind and hydraulic (fluid) power and geophysical energy systems, bio-fuel systems and the design of a renewable energy system for a particular application.

<p>Science, engineering and manufacturing technology</p>	<p>Aerodynamics and the theory of flight</p>	<p>Learners will have an understanding of the physical principles that underpin the design, testing, manufacture and operation of modern aircraft and their associated structures and systems. It will include understanding the forces that act on aircraft during flight and fluid and thermo dynamics, aircraft flight principles and the means by which aircraft are controlled, manoeuvred and stabilised. Learners will be given an opportunity to develop and apply an understanding of the principles of statics, kinetics and dynamics to aircraft structures, linear and angular motion and aircraft systems, the principles of fluid dynamics to the atmosphere and aircraft flight, the principles of thermodynamics to the operation of aircraft propulsion units and fluid systems, and the application of the physics of light and sound to wave propagation, fibre optic transmission, electromagnetic radiation and aircraft communication systems.</p>
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	<p>Robotics and CNC</p>	<p>Learners will have opportunities to further develop their knowledge and skills in two key areas of engineering within the automotive sector – robotic and CNC applications. This will include industrial applications of robots, automation efficiency, robot design and safety, CNC part programming, construction of planning sequences, and safely run programs. This unit will also look at the global dynamics of the automotive sector and its impact on the UK.</p>
	<p>Electrical engineering</p>	<p>Learners will have opportunities to further develop and apply their knowledge and understanding of electrical engineering, looking at specific applications in one or more of the following areas: electronic instrumentation and process control equipment, medical, precision and optical instruments, watches and clocks, electronic components, including semiconductors, navigational devices, office machinery and computers, telecommunications technology, manufacture of electronic components</p>

		including semiconductors, consumer electronics, computers and other IT equipment.
	Electronic engineering	Learners will have opportunities to further develop and apply their knowledge and understanding of electronic engineering within the communications technology field, looking at the concepts and technology involved in telecommunications networks, including network technology, analysis of signals, and data and systems network processes.
	Marine engineering	Learners will have opportunities to further develop their knowledge and skills in the practices and procedures involved within the marine engineering sector, including marine drawings, computer-aided engineering design techniques, structure and strength.
	Mechanical devices and biomechanics	Learners will have opportunities to further develop their understanding and apply the principal concepts and theories of mechanics and mechanical devices and systems, covering engineering materials, statics and dynamics and the effects of forces on

		<p>physical systems, kinematics and the movement of mechanical systems, draughting and communicating the ideas of mechanical systems. Learners will also have an understanding of the underlying principles of biomechanics and an awareness of the importance of biomechanics in human movement and sports performance. A foundation of theoretical principles and the use of biomechanics in the analysis of human movement as part of the sports coaching process will be provided. Mechanical principles and analysis methods will also be covered.</p>
	<p>Further mathematics</p>	<p>Learners will have opportunities to extend their theoretical mathematical understanding, and a greater opportunity to stretch themselves by applying mathematical concepts to a minimum of two engineering areas, including transportation (land, air, sea or space), manufacturing energy generation/processing, engineering systems, electrical/electronics engineering, engineering</p>

		processes and engineering maintenance.
	Advanced business improvement techniques for engineers	Learners will be provided with an in-depth look at the factors that impact on business success within engineering companies, large and small, and current methods of business improvement, covering latest thinking on business improvement techniques, engineering processes and manufacturing, statistical methods and project management.
Passenger transport	Engineering and maintenance in the bus and coach industries	Learners will further develop understanding of engineering and maintenance in the bus and coach industries, including diagnostic processes, vehicle servicing and repairs, complex maintenance activities, tools and materials and diagnostic processes, the importance of controlled engineering procedures and planned maintenance within the bus/coach industries, the impact of the regulatory environment and technological and environmental issues.
	Engineering and maintenance in the rail industry	Learners will further develop understanding of engineering and maintenance in the rail industries, including diagnostic processes,

		vehicle servicing and repairs, complex maintenance activities, tools and materials and diagnostic process, the importance of controlled engineering procedures and planned maintenance within the rail industry, the impact of the regulatory environment and technological and environmental issues.
	Providing customer service	Learners will further develop understanding of the importance of customer service in the passenger transport sector, the impact of technology in the delivery of customer service and the communication of technical information to internal/external customers. Learners will learn about, professional customer service, the consequences of poor customer service and methods of improvement.
Chemical, nuclear, oil and gas, petroleum and polymer industries	Industrial applications of chemical reactions Industrial applications of organic chemistry Practical chemical analysis Plastics processing Polymer science Polymer technology Materials handling and Process Industrial process measurements	Learners will be able to explore in detail various aspects of the gas extraction, chemicals manufacturing and petroleum industries to broaden and deepen their learning.

	Systems measurement and testing Monitoring and fault diagnosis	
Automotive	Advanced skills in vehicle electrical systems	Learners will build on and develop their skills and knowledge in electrical systems. The learner will understand and demonstrate condition and component testing for the starting and electrical charging systems, lighting circuits and components, electrical auxiliary systems.
	Advanced vehicle electronic components	Learners will build on and develop their skills and knowledge in electronic systems. Learners will be able to describe the functions and test motor vehicle batteries, vehicle starter, generator components, electronic components and vehicle auxiliary systems.
Building services engineering	Integrated facilities management and support services	Learners will develop knowledge, skills and understanding, and apply relevant skills in, principles and practices in relation to the full range of services involved in delivering a broad range of discrete and integrated support services, including building maintenance, space management, catering, cleaning and security.

	Building services engineering (electrical)	Learners will develop knowledge, skills and understanding, and apply relevant skills in, the underlying regulations, standards, industry codes of practice and principles associated with the design and installation of low voltage electrical systems for buildings and structures.
	Building services engineering (mechanical)	Learners will develop knowledge, skills and understanding, and apply relevant skills in, regulations, standards, industry codes of practice and principles associated with the design and installation of mechanical engineering services systems (air conditioning and refrigeration, heating and ventilation and plumbing) for buildings and structures.

## **Personal, learning and thinking skills**

32. Awarding organisations must design learning outcomes and assessment criteria that clearly include opportunities for the development of personal, learning and thinking skills (PLTS). All levels of the Diploma principal learning must include all six PLTS. These should be integrated as a minimum within the assessment criteria for principal learning to explicitly recognise the application of these skills within sector relevant contexts.
33. Awarding organisations must also provide a clear mapping of the coverage of PLTS within their submission. This should be at the level requested under each topic within the criteria such as 'independent enquirers'.

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First published by the Office of Qualifications and Examinations Regulation in 2011

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