City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Knowledge) (4705-02)

Version 2.1 (September 2024)

Qualification Handbook

Qualification at a glance

Subject area	Engineering
City & Guilds number	4705
Age group approved	16+
Entry requirements	The apprenticeship standard requires a candidate would have typically achieved 4 GCSEs at Grade C or equivalent, including Mathematics, English and a Science
Assessment	Multiple-choice online tests Short-answer question assessments
Grading	Pass/Merit/Distinction
Approvals	Full approval required
Support materials	Qualification handbook Assessor guide SAQ Assessments
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds qualification number	Regulatory reference number	GLH	TQT
City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Knowledge) (VRQ)	4705-02	601/8099/7	515	648

Version and date	Change detail	Section
1.0 October 2015	Initial version	All
1.1 September 2017	Added TQT details	Qualification at a glance and Structure
	Deleted QCF	Throughout
2.0 February 2022	GLH and TQT clarified and highlighted	Qualification at a glance and Structure
2.1 September 2024	Handbook reviewed and updated to new template	Throughout Assessment

Contents

1 Introduction

This document tells you what you need to do to deliver the qualification:

Area	Description
Who is the qualification for?	This qualification is for those individuals who are over the age of 16 who have an interest in working and progressing in the Aerospace and the Advanced Manufacturing and Engineering sectors.
What does the qualification cover?	This qualification covers the knowledge required for employment and/or career progression in the Aerospace sector and the Advanced Manufacturing and Engineering sector in general.
What opportunities for progression are there?	Learners can progress into the Development Phase of the Aerospace Engineering Apprenticeship Standards, and to the following City & Guilds qualifications: • 4605-02 Level 2 Diploma in Aerospace and Aviation (Foundation Competence) • 1145-30, 31, 32 Level 3 Technicals in Engineering*
Who did we develop the qualification(s) with?	This qualification was developed in collaboration with employers from the Aerospace and Aviation Sector, SEMTA and other Awarding Organisations.
Is it part of an apprenticeship framework or initiative?	This qualification is a mandatory component of the Foundation Phase of the following Apprenticeship Standards: • Aerospace Manufacturing Fitter • Aerospace Manufacturing Electrical, Mechanical and Systems Fitter

* 1145-31 This qualification has been withdrawn and is no longer available for new candidate registrations. For more details regarding this, please contact City & Guilds directly.

Structure

To achieve the City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Knowledge), learners must achieve **five** mandatory units: 201, 202, 203, 204 and 301 plus any **two** optional units from: 205-211.

This qualification is graded Pass/Merit/Distinction. When a learner has achieved the mandatory and optional units required, centres will need to aggregate the grades achieved for each unit and will need to enter the final grade obtained using **one** of the following overall grading modules:

- 901 Pass,
- 902 Merit
- 903 Distinction

This process is explained in detail in the Grading section of this document.

Unit accreditation number	City & Guilds unit number	Unit title	GLH
Mandatory units:			
Learners must achieve all **five** mandatory units.			
D/507/405	4705-201	Principles of aircraft materials and airframe construction	60
Y/507/406	4705-202	Principles of aerodynamics and the theory of flight	90
D/507/406	4705-203	Mathematics and science for engineering	105
H/507/406	4705-204	Business improvement techniques	50
H/507/405	4705-301	Human factors and behaviours in aviation	90
Optional units:			
Learners must achieve **two** units from the optional units.			
K/507/406	4705-205	Principles of aircraft propulsion	60
M/507/4064	4705-206	General engineering principles	60
T/507/406	4705-207	Principles of aircraft electrics and systems	60
A/507/406	4705-208	Principles of welding and fabrication	60
F/507/406	4705-209	Principles of aerospace composite materials	60

J/507/4068	4705-210	Principles of mechanical assembly and fitting	60
L/507/4069	4705-211	Principles of Computer Aided Design (CAD)	60

Total Qualification Time (TQT)

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT comprises of the following two elements:

1) the number of hours that an awarding organisation has assigned to a qualification for guided learning
2) an estimate of the number of hours a learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike guided learning, not under the immediate guidance or supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

Title and level	GLH	TQT
City & Guilds Level 2 Diploma in Aerospace and Aviation Engineering (Foundation Knowledge) (VRQ)	515	648

2 Centre requirements

Approval

Full approval

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the document **Centre Approval Process: Quality Assurance Standards** for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

Resource requirements

Centre staffing

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area(s) for which they are delivering training and/or have experience of providing training (this knowledge must be to the same level as the training being delivered)
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Continuing professional development (CPD)

Centres are expected to support their staff in ensuring that their knowledge remains current of the occupational area and of best practice in delivery, mentoring, training, assessment and quality assurance, and that it takes account of any national or legislative developments.

Quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance. All external quality assurance processes reflect the minimum requirements for verified and moderated assessments, as detailed in the Centre Assessment Standards Scrutiny (CASS), section H2 of Ofqual's General Conditions. For more information on both CASS and City and Guilds Quality Assurance processes visit: the What is CASS? and Quality Assurance Standards documents on the City & Guilds website.

Standards and rigorous quality assurance are maintained by the use of:

- Internal quality assurance
- City & Guilds external quality assurance.

In order to carry out the quality assurance role, Internal Quality Assurers must

- have appropriate teaching and vocational knowledge and expertise
- have experience in quality management/internal quality assurance
- hold or be working towards an appropriate teaching/training/assessing qualification
- be familiar with the occupation and technical content covered within the qualification.

External quality assurance for the qualification will be provided by City & Guilds EQA process. EQAs are appointed by City & Guilds to approve centres, and to monitor the assessment and internal quality assurance carried out by centres. External quality assurance is carried out to ensure that assessment is valid and reliable, and that there is good assessment practice in centres.

The role of the EQA is to:

- provide advice and support to centre staff
- ensure the quality and consistency of assessments and marking/grading within and between centres by the use of systematic sampling
- provide feedback to centres and to City & Guilds.

Learner entry requirements

City & Guilds does not set entry requirements for this qualification. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully.

Age restrictions

This qualification is approved for learners aged 16 or above.

Access arrangements and reasonable adjustments

City & Guilds has considered the design of this qualification and its assessments in order to best support accessibility and inclusion for all learners. We understand however that individuals have diverse learning needs and may require reasonable adjustments to fully participate. Reasonable adjustments, such as additional time or alternative formats, may be provided to accommodate learners with disabilities and support fair access to assessment.

Access arrangements are adjustments that allow candidates with disabilities, special educational needs, and temporary injuries to access the assessment and demonstrate their skills and knowledge without changing the demands of the assessment. These arrangements must be made before assessment takes place.

Equality legislation requires City & Guilds to make reasonable adjustments where a disabled person would be at a substantial disadvantage in undertaking an assessment.

It is the responsibility of the centre to ensure at the start of a programme of learning that candidates will be able to access the requirements of the qualification.

Please refer to the Joint Council for Qualifications (JCQ) access arrangements and reasonable adjustments and access arrangements - when and how applications need to be

made to City & Guilds. For more information documents are available on the City & Guilds website.

3 Delivering the qualification

Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs
- support and guidance they may need when working towards their qualification
- any units they have already completed or credit they have accumulated which is relevant to the qualification
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the learner fully understands the requirements of the qualification, their responsibilities as a learner and the responsibilities of the centre. This information can be recorded on a learning contract.

Inclusion and diversity

City & Guilds is committed to improving inclusion and diversity within the way we work and how we deliver our purpose which is to help people and organisations develop the skills they need for growth.

More information and guidance to support centres in supporting inclusion and diversity through the delivery of City & Guilds qualifications can be found here:

Inclusion and diversity | City & Guilds (cityandguilds.com)

Sustainability

City & Guilds are committed to net zero. Our ambition is to reduce our carbon emissions by at least 50% before 2030 and develop environmentally responsible operations to achieve net zero by 2040 or sooner if we can. City & Guilds is committed to supporting qualifications that support our customers to consider sustainability and their environmental footprint.

More information and guidance to support centres in developing sustainable practices through the delivery of City & Guilds qualifications can be found here:

Our Pathway to Net Zero | City & Guilds (cityandguilds.com)

Centres should consider their own carbon footprint when delivering this qualification and consider reasonable and practical ways of delivering this qualification with sustainability in mind. This could include:

- reviewing purchasing and procurement processes (such as buying in bulk to reduce the amount of travel time and energy, considering and investing in the use of components that can be reused, instead of the use of disposable or single use consumables)

- reusing components wherever possible
- waste procedures (ensuring that waste is minimised, recycling of components is in place wherever possible)
- minimising water use and considering options for reuse/salvage as part of plumbing activities wherever possible.

Support materials

The following resources are available for this qualification:

Description	How to access
Qualification Handbook	www.cityandguilds.com
Assessor guide	www.cityandguilds.com
SAQ assessment (for each unit)	www.cityandguilds.com

4 Assessment

Assessment of the qualification

Candidates must:

- successfully complete **one** assessment for **each** of the mandatory units 201, 202, 204 and 301
- successfully complete **two** assessments for mandatory unit 203
- successfully complete **one** assessment for **each** chosen optional unit.

City & Guilds provides the following assessments to use with this qualification:

Assessment types			
Unit	**Title**	**Assessment method**	**Where to obtain assessment materials**
Mandatory			
4705-201	Principles of aircraft materials and airframe construction	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com
4705-202	Principles of aerodynamics and the theory of flight	Multiple-choice online test The assessment covers all the outcomes in this unit	www.walled-garden.com
4705-203	Mathematics and science for engineering	Multiple-choice online test (**Mathematics** for Engineering) The assessment covers the Mathematics outcomes in this unit	www.walled-garden.com
4705-203	Mathematics and science for engineering	Multiple-choice online test (**Science** for Engineering) The assessment covers the Science outcomes in this unit	www.walled-garden.com
4705-204	Business Improvement techniques	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com
4705-301	Human factors and behaviours in aviation	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com
Optional			
4705-205	Principles of aircraft propulsion	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com
4705-206	General engineering principles	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com

4705-207	Principles of aircraft electrics and systems	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com
4705-208	Principles of welding and fabrication	Short-answer questions	www.cityandguilds.com
4705-209	Principles of aerospace composite materials	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com
4705-210	Principles of mechanical assembly and fitting	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com
4705-211	Principles of Computer Aided Design (CAD)	Short-answer questions The assessment covers all the outcomes in this unit	www.cityandguilds.com

Assessment strategy

Mandatory units 202 and 203 are assessed by multiple-choice online tests, which are graded Pass/Fail only. These assessments are externally set and externally marked.

There are **two** multiple-choice online tests covering unit 203: 203 – Mathematics for engineering and 703 – Science for engineering. Learners must pass **both** tests to achieve this unit.

Mandatory units 201, 301 and 204 are assessed by short-answer questions assessments, set by City & Guilds, internally marked by centres and externally verified. These assessments are graded Pass, Merit and Distinction.

Optional units 205, 206, 207, 208, 209, 210, and 211 are assessed by short-answer questions assessments, set by City & Guilds, internally marked by centres and externally verified. These assessments are graded Pass, Merit and Distinction.

The assessments have all been developed with input from experts in the industry.

Time constraints

The following must be applied to the assessment of this qualification.

Short-answer question assessments:

- each short-answer question assessment has specific time constraints; please refer to the individual assessments and to the Assessment Pack Guidance. Centres finding that assessments are taking longer should contact the Qualification Consultant for guidance.
- all short-answer question assessments must be completed and assessed within the learner's period of registration. Centres should advise learners of any internal timescales for the completion and marking of individual assessments.

Multiple-choice online tests:

- each multiple-choice online test has specific time constraints; please refer to the test specifications below
- all multiple-choice online tests must be sat within the learner's period of registration.

Centres should advise learners of any internal timescales for the individual assessments.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification.

RPL is not allowed for this qualification.

Test specifications

The way the knowledge is covered by each multiple-choice online test is laid out in the tables below:

Graded: Pass/Fail

Pass mark: the pass mark for this examination is set at approx. 60%

These boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the test be identified.

Test: 202	**Duration: 1.5 hours** **Test title: Principles of aerodynamics and the theory of flight**		
Unit	**Outcome**	**Number of questions**	**Percentage %**
202	1 Know the nature of airflow around aerodynamic bodies	12	20
	2 Know the characteristics of the basic wing planform	5	8
	3 Know the forces acting on an aircraft in flight	8	13
	4 Understand basic aircraft control using primary control surfaces	6	10
	5 Understand the nature of aircraft stability and control	13	22
	6 Know the purpose and operation of a range of secondary control surfaces	16	27
	Total	**60**	**100**

Graded: Pass/Fail

Pass mark: the pass mark for this examination is set at approx. 60%

These boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the test be identified.

Test: 203	**Duration: 1.5 hours** **Test title: Mathematics and science for engineering (Mathematics for engineering)**		
Unit	**Outcome**	**Number of questions**	**Percentage %**
203	1 Be able to use arithmetic and algebra to solve problems	28	47
	2 Be able to use simple graphs	14	23
	3 Be able to use different units in engineering problems	18	30
	Total	**60**	**100**

Graded: Pass/Fail

Pass mark: the pass mark for this examination is set at approx. 60%

These grade boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the test be identified.

Test: 703	**Duration: 1.5 hours** **Test title: Mathematics and science for engineering (Science for engineering)**		
Unit	**Outcome**	**Number of questions**	**Percentage %**
703	1 Know the nature of matter	14	23
	2 Know principles of statics	12	20
	3 Understand principles of kinetics	8	13.5
	4 Understand principles of dynamics	8	13.5

	5 Understand principles of fluid dynamics	8	13.5
	6 Know properties of the Earth's atmosphere	10	16.5
	Total	**60**	**100**

Grading

Grading of individual assessments

Individual assessments will be graded Pass/Merit/Distinction where indicated. For this reason, the graded short-answer question assessments in this qualification have been developed to stretch learners beyond the minimum required for a Pass.

The grade boundaries for Pass, Merit and Distinction for each assessment have been set through a judgemental process using technical experts, aimed at defining what the grades for each assessment should mean in practice. The following descriptors are based on that process.

For the units to be achieved, candidates must achieve a minimum of Pass in the short-answer question assessments, as per marking scheme provided for each assessment. The descriptors given here simply provide a baseline against which Merit and Distinction grades can be understood and should **not** be used for grading/marking the assessments.

Pass reflects the minimum requirements that are expressed in the unit, with Merit and Distinction showing progression in the depth and breadth of the learner's knowledge, as well as in the type of cognitive operations learners demonstrate.

Pass

The candidate has a solid understanding of the unit key concepts. Some understanding may be simplistic, narrow or shallow. Individual topics are dealt with separately but understanding is clear. Recall of the unit content is generally accurate, without serious misapprehensions or gaps. Recall may be slow or show signs of difficulty/uncertainty and minor misapprehensions may occur.

Indicators:

- explanations may be a little incoherent or incomplete, but the meaning is on the whole accurate
- the use of illustrations/examples are mostly relevant to the explanation
- relationships between concepts are missing
- reasoning shows comprehension of the main facts
- analyses or evaluations are simplistic but relevant
- sources, when used, are limited but relevant
- main facts are stated accurately

- definitions and descriptions are accurate, but somewhat limited
- diagrams, when used, are mostly correctly annotated, with some minor errors eg spelling.

Merit

The candidate has a sound understanding of the breadth/depth of the relevant concepts. Topics are dealt with in relation to each other and communicated clearly. The breadth and depth of the unit content are recalled in an accurate and complete manner. Recall is confident.

Indicators

- explanations are coherent, complete and accurate
- use of illustrations/examples which accurately and clearly add to/support the explanation
- relationships are made between concepts
- reasoning is plausible and conventional
- analyses and evaluations are methodical and plausible
- information is drawn from a range of appropriate sources and used appropriately
- facts are accurate and cover the breadth and depth of the unit
- definitions and descriptions are clear
- technical language is accurate

Distinction

The candidate has a well-developed understanding of the relevant concepts. Relationships between topics are highly developed and may be set in context; interactions between topics are clearly expressed. There is evidence of understanding of some facts/knowledge which go beyond the requirements of the unit. Recall is automatic and can be brought together making useful connections.

Indicators

- explanations are well thought out, thorough and well-argued/justified
- well-chosen illustrations/ examples, which accurately and precisely clarify explanations
- relationships are brought together to show an understanding of the bigger picture
- reasoning is justified, well-argued and may be creative
- analyses and evaluations are thorough, well-developed
- sourced information is critically evaluated, showing awareness of its importance or relevance
- evidence of interest beyond the scope of the unit
- descriptions and definitions are detailed
- use of knowledge is consistently high and second nature.

Grading of qualification

The Aerospace Apprenticeship Employer Group has taken the decision to grade this qualification Pass/Merit/Distinction, through the aggregation of the individual assessment graded Pass/Merit/Distinction.

Grading can be of use both as a motivational tool within the learning environment and also to learners presenting evidence of their knowledge to prospective employers.

All assessments must be achieved at a minimum of Pass for the qualification to be awarded. All assessments graded Pass/Merit/Distinction contribute equally to the overall qualification grade.

Mandatory units 202 and 203, assessed by multiple-choice online tests 202, 203 and 703, are graded Pass/Fail only. Learners **must** achieve a Pass in these assessments; however, they do **not** contribute to the overall qualification grade.

Centres will need to calculate the qualification grade as follows:

- Centre will mark and grade each graded assessment using the model answer mark scheme provided by City & Guilds and available on **www.cityandguilds.com**
- The grade achieved by a learner will need to be converted into points as follows:

Individual assessment grade	Grade points
Pass	4
Merit	6
Distinction	8

- Grade points for each assessment need to be added together and the overall qualification grade determined using the following conversion table:

Total grade points	Overall qualification grade
20-25	Pass
26-35	Merit
36-40	Distinction

- Overall qualification grades must be entered using **one** of the following overall grading modules on the Walled Garden:
    - 901 Pass
    - 902 Merit
    - 903 Distinction

Example

Learner A has achieved the following:

Assessment	Grade achieved	Grade points
Mandatory		
4705-201	Merit	6
4705-202	Pass	No grade points, as Pass/Fail only
4705-203	Pass	No grade points, as Pass/Fail only
4705-703	Pass	No grade points, as Pass/Fail only
4705-204	Merit	6
4705-301	Distinction	8
Optional		
4705-xxx	Pass	4
4705-yyy	Merit	6
	Total grade points	**30**
	Overall qualification grade	**Merit**

5 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- guided learning hours (GLH)
- unit aim
- assessment type
- learning outcomes, which are comprised of a number of assessment criteria
- range statements
- endorsement by sector or regulatory body.

Guidance for delivery of the units

This qualification comprises a number of **units**. A unit describes what is expected of a competent person in particular aspects of their job.

Each **unit** is divided into **learning outcomes** which describe in further detail the skills and knowledge that a candidate should possess.

Each **learning outcome** has a set of **assessment criteria** (performance and knowledge and understanding) which specify the desired criteria that must be satisfied before an individual can be said to have performed to the agreed standard.

Range statements define the breadth or scope of a learning outcome and its assessment criteria by setting out the various circumstances in which they are to be applied.

Unit 201 Principles of aircraft materials and airframe construction

UAN:	D/507/4058
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	The aim of this unit is to provide learners with an understanding of aircraft materials and airframe construction. The unit provides the learner with knowledge of aircraft the materials used in aircraft manufacturing, for metal airframes as well as composite, including associated components. It also gives the learner the knowledge of the consequences of deterioration of the materials used in the construction and the repair techniques used in maintaining their airworthiness.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Know about aircraft ferrous and non-ferrous materials
2. Know about composite and other, non-metallic materials
3. Know about wood and fabric airframe construction
4. Understand corrosion in aircraft materials
5. Understand the general concepts of airframe structure and construction

Learning outcome:

The learner will:

1. Know about aircraft ferrous and non-ferrous materials

Assessment criteria

The learner can:

1.1 describe the basic characteristics, properties and identification of ferrous materials used in aircraft

1.2 describe heat treatment and applications of alloy steels describe characteristics, properties and identification of non-ferrous metals used in aircraft

1.3 describe heat treatment and applications of non-ferrous materials

Range

1.1

- alloying elements: carbon, chromium, nickel, vanadium, molybdenum, manganese, silicon
- material properties eg: density, strength, elasticity, ductility, malleability, toughness, hardness, brittleness, creep and fatigue resistance, work hardening, corrosion resistance, hot and cold performance
- Identification markings on stock material

1.2

annealing, tempering, quench hardening, normalising, surface hardening, carburising, nitriding, flame hardening, induction hardening

1.3

- common alloying elements: copper, magnesium silicon, zinc
- properties eg: density, strength, elasticity, ductility, malleability, toughness, hardness, brittleness, creep and fatigue resistance, work hardening, corrosion resistance, hot and cold performance
- advanced alloys eg: titanium and aluminium/lithium alloys
- Identification marks on stock material

1.4

annealing, solution treatment, precipitation hardening, stabilisation treatment

Learning outcome

The learner will:

2. Know about composite and other, non-metallic materials

Assessment criteria

The learner can:

2.1 describe characteristics, properties and identification of composite and other, non-metallic materials

2.2 describe characteristics, properties and identification of sealants and bonding agents describe detection of typical defects/deterioration in composite material

2.3 explain typical repair techniques for composite materials explain the preservation and maintenance of non-metallic materials

Range

2.1

- fibres (eg: glass, carbon, boron, aramid)
- typical resins
- sandwich structures
- plastics
- polymers (eg thermoplastics, thermosetting, elastomers)
- sandwich construction
- adhesives and glues

2.2

polyurethane, silicones, thread locking compound, resins, glues

2.3

- defects/deterioration: cracking, warping, splitting, disbanding, delamination, Barely Visible Impact Damage (BVID)
- detection: visual inspection, tap test, ultrasonic, infrared

2.4

- composite materials: pre-impregnated layup (Prepreg), wet layup
- repair techniques: fibre orientation, autoclave, vacuum bag, typical repair tools, safety precautions, material storage procedures, surface finish

2.5

inspection, protective treatments

Learning outcome

The learner will:

3. Know about wood and fabric airframe construction

Assessment criteria

The learner can:

3.1 describe construction methods for wooden airframe structures

3.2 describe characteristics and properties of the types of wood and glue used in aeroplanes

3.3 describe methods of detecting defects in wooden structures

3.4 describe methods of repairing wooden structures

3.5 describe characteristics, properties and types of fabric used in aeroplanes

3.6 describe inspection methods for fabrics

3.7 describe the common defects found in fabrics

3.8 describe common methods of repairing fabric coverings

Range

3.1

- structural members
- fabric or plywood skin
- type of joints
- general direction of grain
- reinforcement
- use of glues, screws and other fasteners

3.2

woods: fir, pine, cedar

glues: resorcinol – formaldehyde resin, epoxy resin

3.3

visual inspection, joint testing, measurement, odour

3.4

splicing, scarf joint, reinforcement, replacement, patching (scarf, splayed, oval, plug)

3.5

- cotton, linen, Dacro, fibre glass
- properties: classification of fabrics, stitching and lacing, anti-tear tape

3.6

- visual inspection
- fabric punch tester
- tensile testing

3.7

tears, deterioration of fabric due to: humidity, extremes of temperature, chemical action, fungal growth, erosion, brittleness, slackness, peeling of re-enforcing fabric from ply wood panels

3.8

- small tears – sew together and dope a pinked patch on top
- larger tears – sewn in patch repairs
- un-sewn doped-on patch repairs
- panel replacement

Learning outcome

The learner will:

4. Understand corrosion in aircraft materials

Assessment criteria

The learner can:

4.1 describe types of corrosion and methods of identifying these in ferrous and non-ferrous metals.

4.2 describe the causes and formation of corrosion in ferrous and non-ferrous metals

4.3 identify materials that are susceptible to corrosion and methods to prevent corrosion

4.4 describe methods of corrosion removal and repair

Range

4.1

- types: surface, pitting, intergranular, fretting, crevice, exfoliation, filiform
- methods: visual inspection, x-ray, chemical analysis of samples

4.2

- causes: environment, wear, stress, fatigue
- formation: microbiological action, direct chemical action, galvanic action process

4.3

- materials: steels, aluminium alloys, magnesium alloys, copper alloys
- methods: design, protection, lubrication, stress and fatigue reduction, selection of appropriate materials

Learning outcome

The learner will:

5. Understand the general concepts of airframe structure and construction

Assessment criteria

The learner can:

5.1 explain the airworthiness requirements for structural strength

5.2 explain the classification of aircraft structure

5.3 describe the physical effects of flying on aircraft structures

5.4 describe construction methods for various airframe components

5.5 describe structural assembly techniques

5.6 describe methods of surface protection and cleaning

Range

5.1

strength-to-weight ratio, rigidity, flexibility

5.2

primary, secondary, tertiary

5.3

stress, strain, bending, compression, shear, torsion, tension, hoop stress, fatigue

5.4

- construction components stressed skin, formers, stringers, longerons, bulkheads, frames, doublers, struts, ties, beams, floor structures, reinforcement
- methods: skinning, anti-corrosive protection
- components: wing, empennage, fuselage and engine attachments

5.5

riveting, bolting, bonding

5.6

chromating, anodising, painting, polishing, use of solvents and detergents

Unit 202 Principles of aerodynamics and the theory of flight

UAN:	Y/507/4060
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit aims to give the learner the knowledge of how gases interact with moving bodies; in the case of aerodynamics, air in the atmosphere. This unit provides the learner with the primary knowledge of the forces of drag and lift which are caused by air passing over and around solid bodies in aerodynamics. Learners will know how lift, weight, thrust and drag associated with theory of flight interact with an aircraft while moving through the air. They will learn about the stability of an aircraft in flight and the various lift augment devices which assist the aircraft during a take-off and landing; the unit provides the learner with the knowledge required at level 2 for Aerospace and Aviation Engineering.
Assessment type	Multiple-choice online test

Learning outcomes

In this unit, the learner will:

1. Know the nature of airflow around aerodynamic bodies
2. Know the characteristics of the basic wing planform
3. Know the forces acting on an aircraft in flight
4. Understand basic aircraft control using primary control surfaces
5. Understand the nature of aircraft stability and control
6. Know the purpose and operation of a range of secondary control surfaces

Learning outcome:

The learner will:

1. Know the nature of airflow around aerodynamic bodies

Assessment criteria

The learner can:

1.1 describe how air flows around an aerodynamic body know how an aerofoil stalls and the effect a stall has on an aircraft in flight

1.2 describe how lift and drag affect aircraft performance

Range

1.1

- know the nature of airflow including streamline, laminar and turbulent flow, free stream flow, up and down wash, vortices; compressibility effects at higher subsonic speeds
- know about viscosity effects and the boundary layer including resistance to motion, velocity gradient, shear rate, boundary layer separation (transition point, separation point)

1.2

- know aerofoil terminology and characteristics including aerofoil profile, camber, upper, lower and mean camber lines, chord line, leading and trailing edge, thickness to chord ratio or fineness ratio, angle of attack (AOA), angle of incidence (AOI) symmetrical and cambered aerofoils
- describe pressure and flow changes at low, medium and high angles of attack and explain aerofoil stall effects

1.3

- lift: describe the factors affecting lift including aerofoil shape, lift coefficient, angle of attack, air density, airspeed and stall
- drag: know different types of drag including total, induced (trailing vortex), profile skin friction, profile form, interference;
- describe common methods of drag reduction; know how the following contribute to drag reduction: polished surfaces, fairings, special materials, aerodynamic shape

Learning outcome:

The learner will:

2. Know the characteristics of the basic wing planform

Assessment criteria

The learner can:

2.1 describe the basic wing planforms and their typical applications

Range

2.1

- know about wing planform designs for aircraft subject to, low subsonic, high subsonic and transonic speed airflows
- know about rectangular, tapered, swept, and delta planforms; applications: low subsonic, high subsonic and transonic speed airflows; generation of lift
- calculate dimensions for each basic wing planform; dimensions: span, aspect ratio, taper ratio, gross wing area, wash in, wash out
- describe the airflow over each basic wing planform – airflow: in normal flight, at or near stall; planforms: rectangular, tapered, swept, delta
- describe the effect of ice, snow and frost build-up on the performance of aerofoils –

  effects: change of shape, increase in weight, variation in thickness

Learning outcome:

The learner will:

3. Know the forces acting on an aircraft in flight

Assessment criteria

The learner can:

3.1 describe the forces acting on an aircraft in flight

3.2 describe the importance of the speed of sound to high-speed aircraft

Range

3.1

- describe airflow with reference to Bernoulli's principle; describe static pressure changes resulting from changes in angle of attack (including around the stall); describe the airflow as the velocity changes; describe effects including changes in lift and drag

- know the relationship between lift, weight, thrust and drag forces for straight and level flight
- describe the effects of streamlining an object in an airflow; definition of streamlining; effects: reduction of compression shockwaves, reduction in drag
- know the factors affecting drag including aerofoil shape, angle of attack, drag coefficient, airspeed, streamlining, damage to lift producing surfaces, ice and frost accretion

3.2

- describe how the speed of sound can vary with height, air density, temperature
- state the meaning of terms related to high-speed flight: speed of sound, subsonic flight, transonic flight, supersonic flight, Mach number, Critical Mach number (MachCrit)
- describe problems that can occur when an aircraft approaches the speed of sound: problems: shockwave, buffet, increased drag, control reversal, tuck-under
- describe design features peculiar to high-speed flight; features of wings, fuselage, engine intakes, control surfaces

Learning outcome:

The learner will:

4. Understand basic aircraft control using primary control surfaces

Assessment criteria

The learner can:

4.1 explain the meaning of ‘aircraft control

4.2 describe typical aircraft performance

4.3 explain the influence of load factor on aerodynamic performance

Range

4.1

- describe the operation and effect of the primary aircraft control surfaces; describe how elevators, ailerons and rudders support control about the aircraft axes
- know about control in roll, pitch and yaw; describe manoeuvring about lateral, longitudinal and normal axes

4.2

- describe different phases of flight; phases: straight and level flight, climb, descent, glide, turn; describe how turning flight changes the loading on an airframe describe how turning flight is related to the stall

4.3

- define load factor and explain its effect on lift generated; state how load factor changes alter the aircraft's flight characteristics
- explain the term 'flight envelope'; explain flight envelope in terms of the loading analysis to which the aircraft design must comply; describe the dependency of the flight envelope on: aircraft gross weight, configuration of the aircraft (cleanliness, external stores, position of flaps, position of landing gear), symmetry of loading, altitude

Learning outcome:

The learner will:

5. Understand the nature of aircraft stability and control

Assessment criteria

The learner can:

5.1 explain stability and control of an aircraft in flight describe major components on an aircraft and how they affect stability in flight

5.2 explain the principles of balancing control surfaces

5.3 describe the purpose of lift augmentation devices and how they work

Range

5.1

- know about flight force, including couples (lift/weight and thrust/drag), action about centre of gravity (CG) and centre of pressure (CP)
- describe stable, unstable and neutrally stable states of equilibrium; understand diagrams that use force vectors to show the different states
- explain the nature of aircraft flight stability; stability: definitions for static, dynamic and passive stability around the longitudinal, lateral and directional axis
- know the different types of stability, including short period pitch oscillation, long period pitch oscillation (phugoid), dutch roll and weather cocking

- know the differences between statically stable, unstable and neutral aircraft, including static and positive stability, negative stability (unstable), zero stability (neutral)

5.2

- describe longitudinal static stability including trim and stability, centre of pressure and aerodynamic centre movement; describe the effect of the tailplane, the centre of gravity position and the effect of loading of stores and cargo
- describe the balancing aerodynamic force from the tailplane; using the principle of moments, determine balancing forces needed to maintain aircraft in static equilibrium
- describe lateral static stability including yawing stability (yawing motion or weather cocking, use of fin, keel surface and wing dihedral), rolling stability (use of high wings and sweepback), use of anhedral
- describe directional stability; describe how the fin (vertical stabiliser) corrects yawing motion, describe how the keel surface area (including area of fin) behind the centre of gravity affects directional stability
- describe methods of enhancing stability, including adjusting the centre of gravity, design of lifting and control surfaces (wings, canards, tailplane)

5.3

explain the reason for balancing, including how flutter can occur and the purpose and methods of mass balance/aerodynamic balance

5.4

define ‘lift augmentation’; know that lift needs augmentation under certain flight conditions including short take-off and landing, slow speed flight, high altitude take-off/landing; know the purpose and operation of: flaps, slats and slots, vortex generators, boundary layer control

Learning outcome:

The learner will:

6. Know the purpose and operation of a range of secondary control surfaces

Assessment criteria

The learner can:

6.1 describe the operation of high drag devices, by stating the limitations in flight and on the ground of: spoilers, lift dumpers and speed brakes

6.2 describe the secondary effects of roll and yaw and methods of overcoming them

6.3 describe the arrangement and operation of alternative and combined flying controls

6.4 describe the aerodynamic problems caused by asymmetric flap operation

6.5 describe the purpose and operation of devices to prevent stalls

Range

6.1

- know how a high lift device alters the flow characteristics of an aerofoil; characteristics: airflow separation, changes in lift and drag coefficients
- know how the total drag of an aircraft is generated; know that total drag is generated by induced drag, pressure or form drag, skin friction, interference drag, parasite drag

6.2

- describe airflow over control surfaces; describe the effect of adverse yaw on roll rate; state ways of counteracting averse yaw and the role of differential ailerons, frise ailerons and roll spoilers
- describe the secondary roll effect of applying rudder and state why this is worse in v-tailed aircraft; describe the co-ordinated use of rudder and aileron; describe the use of rudder limiters

6.3

- describe the arrangement, operation and reasons for: spoilers, all-moving tailplane (slab/stabilator), ailerons, canards, elevons, ruddervators, flaperons, tailerons
- know the performance of trailing edge high-lift devices; state advantages, disadvantages with respect to aerodynamic effectiveness and operation of the following devices: plain flap, split flap, slotted flap, fowler flap
- know the performance of leading edge high-lift devices; state advantages, disadvantages with respect to aerodynamic effectiveness and operation of the following devices: Krueger flap, leading edge droop, slots, slats

6.4

describe asymmetric flap end the effect on aircraft attitude, including asymmetric flap and how it happens, effect on aircraft attitude

6.5

know the operation of stall strips/wedges; know methods of boundary layer control: blown air, suction devices, vortex generators

Unit 203 Mathematics and science for engineering

UAN:	D/507/4061
Level:	2
GLH:	105
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Engineering Apprenticeship Employer Group
Aim:	This unit aims to give the learner the maths and science knowledge in an engineering context to allow further study of manufacturing and maintenance practices.
Assessment type	Multiple-choice online tests

Learning outcomes

In this unit, the learner will:

1. Be able to use arithmetic and algebra to solve problems
2. Be able to use simple graphs
3. Be able to use different units in engineering problems
4. Know the nature of matter
5. Know principles of statics
6. Understand principles of kinetics
7. Understand principles of dynamics
8. Understand principles of fluid dynamics
9. Know properties of the Earth's atmosphere

Learning outcome:

The learner will:

1. Be able to use arithmetic and algebra to solve problems

Assessment criteria

The learner can:

1.1 perform arithmetical calculations

1.2 prioritise and use basic functions within arithmetical calculations

1.3 manipulate fractions and decimals to solve problems

1.4 manipulate ratios, proportions, and percentages to solve problems

1.5 calculate areas and volumes

1.6 calculate simple powers of numbers

1.7 manipulate algebraic expressions

Range

1.1

- add, subtract, multiply, divide, positive and negative integers, decimals and fractions; reduce fractions; convert between mixed numbers and improper fractions
- convert between decimals and fractions; express values to a given number of decimal places; order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, >, ≤, ≥

1.2

understand and use BIDMAS including powers, roots and reciprocals

1.3

identify and work with fractions in ratio problems; interpret fractions and percentages as operators; identify and work with decimals to solve problems

1.4

- use ratio notation, including reduction to simplest form; divide a given quantity into two parts in a given part:part or part:whole ratio; express the division of a quantity into two parts as a ratio; apply ratio to real contexts and problems
- use proportion as equality of ratios: solve problems involving direct and inverse proportion
- use percentages: define percentage as ‘number of parts per hundred’; interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively; express one quantity as a percentage of another; compare two quantities using percentages
- perform engineering calculations involving ratios and proportion: solve problems involving percentage change, including percentage increase/decrease and original value problems

1.5

- state and use formulae for areas of:
    - triangles
    - rectangles
    - circles
    - work out areas of composite shapes made from rectangles, triangles, circles and/or semi-circles
    - use appropriate units

- state and use formulae for volumes of:
    - triangular prisms
    - cuboids
    - cylinders
    - use appropriate units

1.6

calculate squares, square roots, cubes and cube roots; use positive integer powers and associated real roots (square, cube and higher); recognise powers of 2, 3, 4, 5; estimate powers and roots of any given positive number

1.7

- substitute numerical values into formulae and expressions, including scientific formulae; change the subject of a formula, where the subject appears only once
- simplify, change the form of and evaluate algebraic expressions by:
    - collecting like terms
    - multiplying a single term over a bracket
    - taking out common factors
    - expanding products of two or more binomials

Learning outcome:

The learner will:

2. Be able to use simple graphs

Assessment criteria

The learner can:

2.1 apply the basic principles of graphical representation

2.2 extract data from graphs used in engineering

Range

2.1

- know about axes, grid lines, origin, scales; working with coordinates in all four quadrants; identify constant, linear, quadratic, cubic and trigonometric functions straight-line graphs in the coordinate plane; use the form y = mx + c
- find the equation of the line through two given points or through one point with a given gradient; identify gradients and intercepts of linear functions graphically and algebraically

2.2

- interpret graphs including: graphs of linear, quadratic and trigonometric functions
- interpret graphs of non-standard functions in real contexts to find approximate solutions to problems such as simple kinematic problems involving distance, speed and acceleration
- calculate or estimate gradients of graphs and areas under graphs and interpret results in cases such as distance-time graphs, velocity-time graphs, ICAO temp/altitude, fuel data, engine performance

Learning outcome:

The learner will:

3. Be able to use different units in engineering problems

Assessment criteria

The learner can:

3.1 solve problems using equations of motion , force, work, power and energy

3.2 solve problems involving imperial, US customary and SI units

Range

3.1

- state base units and symbols for: time, length, mass; state and use derived units and associated formulae for: speed, velocity, acceleration, force, work, power and energy
- know the difference between speed, velocity and acceleration; know and use the relationship between average speed, distance moved and time; average speed = distance moved/ time taken
- know and use equations of motion:

  a = (v - u)/ t; v=u+at; v2 – u2 = 2as; s=(u+v)t/2; s=ut + at2/2
- use the equation: Force (newton, N) = mass (kilogram, kg) x acceleration (metre per second squared, m/s2) F = m x a
- use the relationship between work, force and distance moved in the direction of the force: work done = force × distance moved; W = F × d; know that work done is equal to energy transferred; describe power as the rate of transfer of energy or the rate of doing work; Power = work done/time taken; P = W/t; carry out simple calculations
- know and use the relationship: gravitational potential energy = mass × g × height; GPE = m × g × h; know and use the relationship: kinetic energy = ½ × mass × speed2; KE = 1/2× m × v2

3.2

- state the meaning of prefixes used with SI units: state the meaning of prefixes and identify symbols for micro, milli, kilo, Mega; convert between prefixes using both positive and negative indices; state the imperial units and representative symbols including US gallons and US (short) ton; state US customary units used in aviation
- convert between Imperial, US customary and SI units:
  - Imperial: inch, foot, yard, mile, stone, pound, ounce, tonne, square foot, cubic inch, cubic foot, fluid ounce, pint, gallon, mile per hour, horsepower.
  - US customary: US fluid ounce, US fluid pint, US quart, US gallon, US (short) ton, US ounce, US pound, hundredweight; foot-pound force, Fahrenheit.
  - SI: kilometre, metre, centimetre, millimetre, kilogram, gram, square metre, cubic metre, litres, metre per second, metre per second per second, newton, joule, watt, Kelvin

Learning outcome:

The learner will:

4. Know the nature of matter

Assessment criteria

The learner can:

4.1 describe the structure of atoms

4.2 explain concepts of chemical elements

4.3 explain concepts of chemical compounds

4.4 define the three ‘classical’ states of matter

Range

4.1

know that atoms consist of a central nucleus, composed of protons and neutrons, surrounded by electrons, orbiting in shells; know the meaning and representation of the terms ‘atomic number’, ‘mass number’ and ‘relative atomic mass’; the relative charge and relative mass of a proton, a neutron and an electron; know that atoms contain equal numbers of protons and electrons

4.2

- define ‘element’; know about elements as metals or non-metals according to their position in the periodic table; know how elements are different from one another; know that the Periodic Table is an arrangement of elements in order of atomic number; elements are arranged in the periodic table in order of increasing atomic number, in rows called periods; elements with similar properties are placed in the same vertical column – these columns are called groups
- understand basic element structure; deduce the electronic configurations of the first 20 elements from their positions in the Periodic Table and in the form 2.8.1; understand the connection between the number of outer electrons and the position of an element in the periodic table; understand why elements in the same group of the Periodic Table have similar chemical properties

4.3

- define molecule, compound, mixture; use the periodic table to recognise elements and formulae of simple compounds
- chemical bonds – ionic compounds: describe the formation of ions by the gain or loss of electrons; understand ionic bonding as a strong electrostatic attraction between

oppositely charged ions; understand the relationship between ionic charge and the melting point and boiling point of an ionic compound

- covalent substances: describe the formation of a covalent bond by the sharing of a pair of electrons between two atoms; understand covalent bonding as a strong attraction between the bonding pair of electrons and the nuclei of the atoms involved in the bond; understand that substances with simple molecular structures are gases or liquids, or solids with low melting points; explain the high melting and boiling points of substances with giant covalent structures in terms of the breaking of many strong covalent bonds
- metallic crystals: understand that a metal can be described as a giant structure of positive ions surrounded by a sea of delocalised electrons; explain the electrical conductivity and malleability of a metal in terms of its structure and bonding

4.4

- solid, liquid and gas:
    - know the arrangement, movement and energy of the particles in each of the three states of matter
    - know how the inter-conversions of solids, liquids and gases are achieved and recall the names used for these inter-conversions; explain the changes in arrangement, movement and energy of particles during these inter-conversions.

Learning outcome:

The learner will:

5. Know principles of statics

Assessment criteria

The learner can:

5.1 explain forces, moments and couples

5.2 make calculations involving forces, moments and couples (using SI units only)

5.3 explain stress, strain, elasticity, compression, shear, tensile and torsion

Range

5.1

- forces and stress: be able to apply the formulae force (F = ma = mg), mass/weight relationship (W = mg); understand the vector representation of forces, moments and couples using simple diagrams
- apply these principles to simply supported beams (weight of beam, concentrated load, uniformly distributed load, reactions); understand that the upward forces on a light beam, supported at its ends, vary with the position of a heavy object placed on the beam

5.2

- force: be able to interpret free-body force diagrams to represent forces on a particle or on a rigid body; carry out calculations for force, moments, couples; be able to use the equation for the moment of a force: moment of force = Fx where x is the perpendicular distance between the line of action of the force and the axis of rotation
- know and use the principle of moments for a simple system of parallel forces acting in one plane; be able to use the concept of centre of gravity of a body and apply the principle of moments to a body in equilibrium

5.3

- define and explain the basics of: stress, strain, elasticity, compression, shear, torsion; be able to use the Hooke's law equation, F = kx, where k is the stiffness of the object; understand that the initial linear region of a force-extension graph is associated with Hooke's law; explain elastic behaviour as the ability of a material to recover its original shape after the forces causing deformation have been removed
- be able to use the relationship:
    - (tensile/compressive) stress = force/cross-sectional area

- (tensile/compressive) strain= change in length/original length
- Young's modulus = stress/strain; be able to interpret force-extension and force-compression graphs; understand the terms limit of proportionality, elastic limit, yield point, elastic deformation and plastic deformation and be able to apply them to these graphs

Learning outcome:

The learner will:

6. Understand principles of kinetics

Assessment criteria

The learner can:

6.1 explain basic principles of rotational movement

6.2 explain basic principles of periodic motion

Range

6.1

- explain and apply basic principles of uniform circular movement; be able to express angular displacement in radians and in degrees, and convert between these units; understand what is meant by angular velocity and be able to use the equations

  $v = \omega r$ and $T = 2\pi/\omega$

- centrifugal/centripetal acceleration; be able to use the equations:

  $a=v2/r = r\ \omega 2$

- understand that a resultant force (centripetal force) is required to produce and maintain circular motion; be able to use the equations for centripetal force: $F=ma = mv2/r = mr\omega 2$; carry out calculations involving rotational motion

6.2

- explain and apply basic principles of periodic motion:
  - define pendula movement; be able to use the equation for a simple pendulum $T=2\pi\sqrt{l/g}$
  - understand the simple theory of: vibration, harmonic, resonance

Learning outcome:

The learner will:

7. Understand principles of dynamics

Assessment criteria

The learner can:

7.1 explain principles of dynamics involving heat

7.2 explain gyroscopic principles

7.3 explain properties of simple mechanical systems

Range

7.1

- explain and use the basic principles: energy transfers from one place to another by conduction, convection, radiation; units - Joule(J) as the unit of energy, watt(W) as the unit of power; be able to use the equations relating power, time and energy transferred or work done P = E/t; and P = W/t Efficiency: be able to use the equations:
    - Efficiency = useful energy output/total energy input
    - Efficiency = useful power output/total power input

7.2

explain the purpose of a gyroscope and its application in aircraft; understand the function of component parts of a basic gyroscope (including spinning mass, gimbals); explain safety precautions for working with gyroscopic equipment

7.3

- explain and use basic lifting system principles: velocity ratio, mechanical advantage, efficiency; carry out calculations involving simple mechanical systems.
- understand coefficient of friction, static and dynamic friction; be able to use the formula $F=\mu R$

Learning outcome:

The learner will:

8. Understand principles of fluid dynamics

Assessment criteria

The learner can:

8.1 describe properties of solids, liquids and gases

8.2 explain the Venturi effect

Range

8.1

- know about the basic properties including shape, viscosity, volume, compressibility; be able to use the equation density=m/V; know the difference between density and specific gravity; know that barometers measure pressure
- explain pressure, buoyancy and upthrust in liquids; be able to use the relationship upthrust=weight of fluid displaced; be able to solve problems involving pressure at depth in a fluid; use the relationship: $P=\rho gh$
- effects of compressibility in a fluid: explain basic principles (water is incompressible and gases are compressible); understand that the pressure at a point in a fluid which is at rest acts equally in all directions; qualitative effects of contaminants (corrosion, cavitation, foaming, sludges and gel, decomposition)

8.2

understand that there is a reduction in fluid pressure when a fluid flows through a constricted section of pipe; understand Bernoulli's Principle, that the air pressure in a tube goes down when the velocity of the air in the tube increases; simplified form of Bernoulli's equation: static pressure +dynamic pressure = total pressure; understand how the Venturi effect and the Bernoulli principle are used in engineering design (hydraulics, pneumatics, carburation, pitot)

Learning outcome:

The learner will:

9. Know properties of the Earth's atmosphere

Assessment criteria

The learner can:

9.1 describe the relationship between the three main temperature scales (Fahrenheit, Centigrade and Kelvin)

9.2 describe the composition and structure of the Earth's atmosphere

9.3 explain how pressure, density and temperature vary with altitude

Range

9.1

- know why there is an absolute zero of temperature which is –273 degrees Centigrade; describe the Kelvin scale of temperature and be able to convert between the Kelvin and Celsius scales; know that an increase in temperature results in an increase in the average speed of gas molecules; know that the Kelvin temperature of the gas is proportional to the average kinetic energy of its molecules
- describe the qualitative relationship between pressure and Kelvin temperature for a gas in a sealed container; use the relationship between the pressure and Kelvin temperature of a fixed mass of gas at constant volume: p1/T1 = p2/T2; use the relationship between the pressure and volume of a fixed mass of gas at constant temperature: p1V1 = p2V2

9.2

- percentages of gases: know that dry air contains 78% nitrogen, 21% oxygen, 0.9% argon, 0.04% carbon dioxide, and small amounts of other gases. Air also contains water vapour, approximately 1% at sea level and 0.4% over the entire atmosphere; know about the layers of the atmosphere: exosphere, thermosphere, mesosphere, stratosphere, troposphere

9.3

- understand pressure, density and temperature variations in the different layers of the atmosphere; Know that density is calculated from measurements of temperature, pressure and humidity; understand ISA graphs showing temperature and pressure variations at different altitudes
- explain and illustrate the relationship between atmospheric pressure, absolute pressure and differential pressure using simple examples; explain the need for a standard atmosphere; understand standard measurements, particularly of altitude; standardisation of instruments/displays, engine performance.

Unit 204 Business improvement techniques

UAN:	H/507/4062
Level:	2
GLH:	50
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit aims to provide the learner with the knowledge of lean business process and quality improvement in order to effectively monitor and make enhancements to production, manufacturing and maintenance processes.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Know what is meant by continuous improvement
2. Understand what is meant by workplace organisation
3. Know what is meant by visual management
4. Understand problem-solving techniques

Learning outcome:

The learner will:

1. Know what is meant by continuous improvement

Assessment criteria

The learner can:

1.1 explain the meaning of continuous improvement

1.2 outline the benefits of applying continuous improvement techniques

1.3 define each stage of the Plan – Do – Check – Act (PDCA) improvement cycle

1.4 define the different categories of waste

Range

1.2

- benefits:
  - reduced cost (e.g. production)
  - improved quality (e.g. reduced defects)
  - improved safety (e.g. safe to use)
  - improved working practices (e.g. reduced operator motion)
  - improved delivery (e.g. reduced transportation time, reduced lead time)
  - reduction of waste (e.g. over processing, excess inventory)
  - resource utilisation (e.g. reduced waiting time)
  - improved customer satisfaction (e.g. meeting customer requirements)

1.3

- categories of work:
  - value added
  - non-value added
  - waste

1.4

- categories of waste:
  - transport
  - inventory
  - motion
  - waiting
  - over-production
  - over-processing
  - defects
  - skills/unrecognised people potential

Learning outcome:

The learner will:

2. Understand what is meant by workplace organisation

Assessment criteria

The learner can:

2.1 explain the meaning of workplace organisation

2.2 outline the benefits of having an organised working environment

2.3 describe the effect an unorganised work environment may have

2.4 explain the importance of Standard Operating Procedures (SOPs) within workplace organisation

Range

2.3

- effects:
  - poor quality
  - increased costs
  - reduced efficiency
  - poor delivery times
  - poor morale/teamwork
  - poor health and safety

Learning outcome:

The learner will:

3. Know what is meant by visual management

Assessment criteria

The learner can:

3.1 explain the meaning of visual management

3.2 describe the benefits of applying good visual management

3.3 describe different types of visual management

Range

3.2

- good visual management: e.g.
  - accurate and relevant
  - eye-catching
  - simple
  - greater ownership

3.3

- visual management: e.g.
  - shadow boards
  - PDCA worksheets
  - colour coding
  - floor footprints
  - storyboards
  - gauges
  - photographs/pictures
  - labelling
  - lights
  - schedule boards
  - Kanban (pull systems)
  - graphs
  - management boards
  - other area specific types of visual management

Learning outcome:

- The learner will:

4. Understand problem-solving techniques

Assessment criteria

The learner can:

4.1 explain what is meant by a problem within a work environment

4.2 describe the benefits of solving work related problems

4.3 outline different techniques used for identifying and analysing problems

4.4 explain the importance of applying the appropriate corrective action and eliminating the root cause of a problem

Range

4.3

- techniques: e.g.
  - tally charts
  - flowcharts
  - histogram/Pareto chart
  - benchmarking
  - process mapping
  - correlation diagram
  - run diagram
  - Statistical Process Control
  - control charts
  - Gantt charts
  - root cause paths
  - value stream maps
  - Ishikawa diagrams (cause and effect, fishbone)
  - brainstorming
  - mind mapping
  - 5 Why analysis

Unit 205 Principles of aircraft propulsion

UAN:	K/507/4063
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit aims to give the learner the knowledge and understanding of the different methods used to power an aircraft through the air. Learners will know about the principal force created by propulsion which leads to movement of the aircraft and will gain an understanding of the source of mechanical power and propulsion.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Understand the principles of aircraft gas turbine engines
2. Understand the operation of gas turbine engines
3. Know the principles of aircraft piston engines and their performance
4. Know the construction of aircraft piston engines
5. Know the aspects of rotary wing aerodynamics
6. Understand propeller theory

Learning outcome:

The learner will:

1. Understand the principles of aircraft gas turbine engines

Assessment criteria

The learner can:

1.1 explain the need for gas turbine propulsion.

1.2 describe how the laws of motion and energy apply to the operation of gas turbine engines

1.3 describe shaped ducts and their effects on gas flows

1.4 describe the constructional arrangement of turbojet, turbo-fan, turbo-shaft and turbo-prop engines

Range

1.1

- limitations of a piston engine
- requirement to fly high and fast
- fuel economy
- power

1.2

- Newton's Third Law of Motion
- force
- work
- power
- energy
- acceleration

1.3

- shaped ducts
    - inlet
    - convergent and divergent ducts

- intake design eg: pod, side, bifurcated, wing root, bellmouth, variable geometry, chin
- intake, S-duct

- the effect shaped ducts have on gas flows
  - velocity
  - temperature
  - acceleration
  - intake anti-icing

1.4

- compressor
- combustion
- turbine
- exhaust
- engine spools
- gearboxes including output drives
- propellers and rotors

Learning outcome:

The learner will:

2. Understand the operation of gas turbine engines

Assessment criteria

The learner can:

2.1 describe the operation of a compressor section

2.2 describe the operation of a combustion section

2.3 describe the operation of a turbine section

2.4 describe the operation of an exhaust section

2.5 describe the operation of the main gas turbine engine types

Range

2.1

- purpose
- axial flow compressor
- centrifugal compressor
- single, twin and multi-spool compressors
- rotors
- stators
- airflow

2.2

- purpose
- typical materials
- combustion chambers
- air/fuel ratio

2.3

- purpose
- materials

- lp and hp turbines

2.4

- purpose
- jet pipe/exhaust unit/propelling nozzle
- noise suppression
- reverse thrust
- thrust augmentation

2.5

- the Brayton cycle
- turbojet
- turbo-prop
- turbo-shaft
- bypass (fan) engine
- torque producing engines
- thrust producing engines
- engine rating and factors affecting performance

Learning outcome:

The learner will:

3. Know the principles of aircraft piston engines and their performance

Assessment criteria

The learner can:

3.1 description and simple calculations for the following efficiencies

3.2 describe the operating principles of different types of reciprocating engine

3.3 describe what is meant by piston displacement and compression ratio

3.4 describe different engine configurations and their firing order

3.5 describe the factors affecting engine power

3.6 describe fuel/air mixture and the effects of altering it

Range

3.1

- description and simple calculations for the following efficiencies:
    - thermal eg: the ratio of work done to fuel used, expressed in heat or work units
    - mechanical eg: the ratio of power developed by expanding gas in the cylinders to the power delivered to the output shaft
    - volumetric eg: the volume of fuel/air charge (temperature and pressure corrected) compared with the total piston displacement of the engine (expressed as a percentage)

3.2

- Top Dead Centre (TDC), Bottom Dead Centre (BDC), clearance
- volume, bore, stroke, swept volume, firing order, ignition timing, valve timing, ‘heat engine’, ‘reciprocating engine’
- methods of ignition (spark and compression), arrangement of each
- the Otto cycle – events during induction, compression, power and exhaust strokes
- requirements for an engine suitable for aircraft eg: reliability, durability, maintainability, compactness, high power/weight ratio, high specific power output, fuel economy, low vibration, flexibility, cost

3.4

- basic layout of in-line, vee and opposed engines
- importance of numbering cylinders and different
- manufacturer conventions for similar engines
- firing order in different engine configurations
- effect of the number of cylinders on smoothness of running

3.5

- icing
- altitude
- temperature
- ram air
- barometric pressure

- humidity
- manifold pressure
- Brake Specific Fuel Consumption (BSFC) and calculations from given data

3.6

- approximate fuel/air ratios:
  - rich best power mixture
  - lean best power mixture
  - cruise power mixture
  - ‘stoichiometric’ mixture
- effects of varying mixture at different power settings
- causes of pre-ignition, backfire etc.

Learning outcome:

The learner will:

4. Know the construction of aircraft piston engines

Assessment criteria

The learner can:

4.1 describe the construction and assembly, testing and function of the crank case and its contents

4.2 describe the construction, assembly, testing and function of accessory gearboxes

4.3 describe the construction, assembly, testing and function of cylinders, pistons and connecting rod assemblies

4.4 describe the construction, assembly, testing and function of inlet and exhaust manifolds

4.5 describe the construction, assembly, testing and function of valve mechanisms

4.6 describe the construction, assembly, testing and function of propeller reduction gearboxes

Range

4.1

- constructional features, function, classification, materials of items including: crank shaft, cam shafts, sumps, counterweights, vibration dampers, ball bearings (including thrust bearings, representative plain and roller bearings, oil seals)
- typical defects to be found in the above, with causes and corrective action
- routine inspection and replacement of seals, packing and gaskets
- routine inspection of crankshafts and measurement of run-out
- maintenance of magnesium castings
- torque loading of components

4.2

- purpose
- typical design
- components
- lubrication
- location
- fitting
- operation
- maintenance
- routine inspection
- typical defects
- causes
- corrective action

4.3

- constructional features, function, classification, materials of: pistons, gudgeon pins (fixed and floating), piston rings, cylinders, cylinder heads and connecting rods
- typical defects associated with each of the above – routine inspection, detection, cause, corrective action
- types of cylinder bore surface – rough, smooth, reasons for each, precautions when working with each, types of piston ring for each

- maintenance of piston rings – gap measurement, adjustment
- piston ring stagger - reasons
- compression testing – equipment, methods, typical results, limits
- removing and fitting cylinder assemblies
- attachment of cylinder heads and bores

4.4

- constructional features, function and materials of exhaust and inlet manifolds
- attachment, gaskets and seals, routine inspection, typical defects, corrective action

4.5

- cam followers, push rods, inlet and exhaust valves sodium filled exhaust valves, seats, guides, springs, rocker assemblies, tappets (including hydraulic)
- valve springs, fitting, number on each valve, prevention of binding
- checking of valve for bowing of stems, pitting, glazing and chipping
- valve clearances: purpose, procedure for checking and adjustment on engines with camshafts, effects of excessive valve clearance on valve timing and engine performance
- typical defects, routine inspection, causes, corrective action associated with valves and their operating mechanisms

4.6

- purpose, construction, attachment to engine, propeller attachment, lubrication, routine inspection, typical faults, causes and corrective actions.

Learning outcome:

The learner will:

5. Understand propeller theory

Assessment criteria

The learner can:

5.1 explain blade element theory.

5.2 explain the effects of varying blade angles, angle of attack and rotational speed on the propeller blade

5.3 explain and calculate propeller slip

5.4 explain the aerodynamic, centrifugal and thrust forces on a propeller

5.5 explain the torque effect of a propeller

5.6 explain the effect of relative airflow on a blade's angle of attack

5.7 explain vibration and resonance produced by a propeller

Range

5.1

- general configuration: fixed and variable pitch
- parts of the propeller, features of the blades
- division of the blades into an infinite number of thin elements used to calculate total forces on the blade

5.2

- coarse and fine pitch
- combinations of rotational speed, blade angle and angle of attack in different phases of flight

5.3

geometric pitch and effective pitch

Learning outcome:

The learner will:

6. Know the aspects of rotary wing aerodynamics

Assessment criteria

The learner can:

6.1 describe terminology related to rotary wing aerodynamics

6.2 describe the effects of gyroscopic precision

6.3 describe torque reaction and directional control

6.4 describe dissymmetry of lift, blade tip stall

6.5 describe the translating tendency and its correction

6.6 describe the Coriolis effect and its compensation

6.7 describe ground effect

6.8 describe vortex ring state, power settling, over-pitching

6.9 describe the principles of auto-rotation and its effects

Range

6.1

- rotary wing flight: rotor blade architecture, production of lift by rotor blades considered as a spinning disc, control of lift and conversion into motion in vertical and horizontal planes, control of helicopter attitude and motion by altering rotor blade, rotor blade behaviour (eg: flap up, flap down, coning, blade tip vortex)
- configurations of rotorcraft eg: autogyro, dual rotor, single rotor

6.2

application of basic gyroscope theory to a rotary wing aircraft: definition of gyroscopic precession and effect on a spinning mass eg: rotor blades

6.3

- how torque is generated on helicopter with a single turning main rotor
- how dual rotor systems cancel out the torque
- different types of anti-torque system eg: variable pitch tail rotor, Fenestron (fan-in-tail), low pressure air duct producing a ‘Coanda effect’ lift force
- how directional control is achieved

6.4

- definition of lift dissymmetry
- cause eg: differential relative airflow across the main rotor disc in forward flight
- effect on the aircraft without correction
- designed-in corrective action (eg: flap up and flap down)
- effect of increasing forward speed leading to retreating blade tip stall
- limiting effect on top speed (VNE)

6.5

- definition of translation tendency (drift) in a hovering single rotor helicopter
- counteracting translation tendency eg: tilting the main rotor mast, adjustment of flight control rigging, bias on the cyclic pitch control

6.6

- definition of the Coriolis Effect (Law of conservation of Angular Momentum)
- effect on spinning rotor blades
- effect on flight
- counteraction measures eg: underslung rotor, dampers, blade twist

6.7

definition of ground effect and illustrate airflow through the rotor and underneath the aircraft

6.8

- definition of vortex ring state (settling with power)
- conditions under which it happens: eg: low forward speed with high upflow into the rotor, descending exit from a ground effect hover, autorotation recovery
- effects eg: loss of rotor efficiency, secondary vortex ring, uncommanded pitch and roll oscillations, little or no cyclic authority
- corrective action eg: increase forward speed and/or partially lower the collective
- definition of over-pitching

6.9

- principles of autorotation, freewheeling unit, use of controls
- autorotation with forward speed – blade regions
- vertical autorotation – blade regions
- effects of excessively high or low autorotation RPM

Unit 206 General engineering principles

UAN:	M/507/4064
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit provides the learner with the knowledge of the basic engineering principles used in production, manufacturing and maintenance. Learners will know about the relevant materials used including the properties of materials affected by heat, as well as the tools and marking techniques used.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Know how to select engineering materials
2. Understand the properties of materials and the effects of heat treatment
3. Know forms of communication used within engineering
4. Know the basic tools and techniques used in engineering
5. Know measurement and marking out techniques
6. Know about the types of Computer Numerical Control (CNC) machines and their uses

Learning outcome:

The learner will:

1. Know how to select engineering materials

Assessment criteria

The learner can:

1.1 describe the different classifications of materials used within engineering applications

1.2 describe the range of materials commonly used within engineering applications

1.3 describe the factors that make materials suitable for different engineering applications

1.4 describe different forms of supply of engineering materials

Range

1.2

metallic (pure metals and alloys, ferrous and non-ferrous), non-metallic materials, composites, natural materials, thermoplastics, thermosetting plastics, ceramics, polymers, smart materials

1.2

low carbon/mild steel, high carbon steel, stainless steel, cast iron, aluminium/aluminium alloys, brass/brass alloys, plastics, composites, other specific materials

1.3

properties, surface finish, cost, quantity, processing requirements, mode of delivery

1.4

sheet, plate, bar, wire, section, extrusions, castings, wrought, forgings, pipe and tube, hot and cold rolled, ingots, pressings, other specific forms of supply

Learning outcome:

The learner will:

2. Understand the properties of materials and the effects of heat treatment

Assessment criteria

The learner can:

2.1 explain what is meant by the mechanical properties of materials

2.2 describe the different effects heat can have on the properties of different types of material

2.3 explain why different properties make materials suitable for different engineering applications

Range

2.1

density, manufacturability, strength (yield, tensile, fracture), elastic limit, proportional limit, ductility, toughness, fatigue

2.2

- effects, e.g.
  - increase in property
  - decrease in property
  - no change to property
  - hardening
  - softening
- heat treatment properties
  - tempering
  - annealing
  - normalising

2.3

heat resistance, thermal and electrical conductivity, thermal and electrical insulation, wear resistance, corrosion resistance, load bearing capacity, shear strength, weight, cost

Learning outcome:

The learner will:

3. Know forms of communication used within engineering

Assessment criteria

The learner can:

3.1 describe the merits and limitations of different forms of communication

3.2 describe basic drawing conventions/layouts

3.3 describe different types of lines, detailing, and dimensioning

3.4 outline how IT/ICT is applied within engineering

Range

3.1

verbal, written, electronic, graphical

3.2

- conventions/layouts, e.g.
  - isometric
  - oblique
  - first and third angle projection
  - other types of drawing (detail, assembly, circuit and wiring, block diagrams)
  - sketches

3.3

- types, e.g.
  - presentation
  - line types
  - abbreviations
  - hatching
  - symbols
  - sections

3.4

- Computer Aided Design (CAD)
- Computer Aided Manufacture (CAM)
- Computer Numerical Control (CNC)
- simulation packages
- rapid prototyping/3D printing

Learning outcome:

The learner will:

4. Know the basic tools and techniques used in engineering

Assessment criteria

The learner can:

4.1 describe different work and tool holding methods and their applications within engineering

4.2 describe tool types and their uses

4.3 outline the basic screw thread forms and their uses

4.4 outline the basic methods of work assembly

Range

4.1

- work and tool holding methods, e.g.
  - vices
  - clamps
  - jigs
  - fixtures
  - collets
  - chucks
  - sleeves
  - angle plates
  - mandrels

4.2

- tool types, e.g.
  - hand tools
  - turning (e.g. facing off, thread cutting, taper turning, drilling, boring)
  - milling/routing (e.g. slot drilling, end milling, face milling, use of a rotary table)

4.3

Metric, Imperial, other alternatives

4.4

thermal, adhesive, mechanical

Learning outcome:

The learner will:

5. Know measurement and marking out techniques

Assessment criteria

The learner can:

5.1 describe the sources of information used in engineering to support marking out activities

5.2 describe different types of measuring and marking out equipment commonly used

5.3 describe surface preparation methods and the importance of surface preparation before marking out

5.4 describe different measuring and marking out techniques

5.5 describe methods of supporting work pieces whilst measuring or marking out

5.6 describe the errors that can occur when measuring and marking out

Range

5.1

- sources, e.g.
  - engineering drawings
  - circuit drawings
  - sketches
  - work instructions
  - computer data
  - data sheets
  - reference charts

5.2

- types, e.g.
  - rules
  - tapes
  - scribers and scribing blocks
  - squares

- DTIs
- verniers
- trammels
- protractors
- micrometers (Metric and Imperial)
- surface plate
- combination sets
- roughness comparison gauges
- any other measuring and marking out equipment

5.3

- methods, e.g.
  - degreasing
  - bluing
  - deburring
  - any other methods

5.4

- techniques, e.g.
  - using templates
  - using marking datum
  - hole centres
  - centre lines
  - angular and radial profiles

5.5

- methods, e.g.
  - marking out tables and plates
  - angle plates
  - parallel strips
  - vee blocks

- jack screws
- clamps

- vices

5.6

- errors, e.g
  - observation errors
  - recording errors
  - unit error
  - calibration errors

Learning outcome:

The learner will:

6. Know about the types of Computer Numerical Control (CNC) machines and their uses

Assessment criteria

The learner can:

6.1 describe the differences between traditional and CNC machining techniques/machine tools

6.2 describe the key features and techniques of different types of CNC machine

6.3 outline how different CNC machines are used to produce given products or components

Range

6.2

types: 2-axis CNC lathe, turnmill centre, milling machine, router, machining centre

Unit 207 Principles of aircraft electrics and systems

UAN:	T/507/4065
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit provides the learner with the knowledge of aircraft electrics and associated systems to allow for further study on specific systems.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Understand electrical concepts
2. Know about direct current power sources and machines
3. Know the principles of alternating current
4. Know about aircraft electrical devices and data transmission

Learning outcome:

The learner will:

1. Understand electrical concepts

Assessment criteria

The learner can:

1.1 explain the difference between a conductor and an insulator

1.2 explain static electricity and conduction

1.3 explain the build-up of static charge on an aircraft surface

1.4 explain electrical terms

1.5 perform calculations involving ohm's law

1.6 calculate current division through series and parallel stages in a network

1.7 calculate voltage drop across series and parallel stages in a network

1.8 describe ways in which electricity can be produced

1.9 explain the purpose of a capacitor

1.10 describe the construction of a capacitor

1.11 explain the operation of a capacitor

Range

1.1

in terms of electron theory:

- structure and distribution of electrical charges within atoms, molecules, ions and compounds
- molecular structure of conductors, semi-conductors and insulators

1.2

- static electricity and distribution of electrical charges
- electrostatic laws of attraction and repulsion
- units of charge
- Coulomb's Law
- conduction of electricity in solids, liquids and gases, and in a vacuum

1.3

- static build-up
- how to prevent static build-up, e.g.:
    - conductive tyres
    - static wick dischargers

1.4

potential difference, Electromotive force (EMF), voltage, current, resistance, conductance, charge, conventional current flow, electron flow

1.5

series, parallel and series-parallel circuits, calculations for resistance circuits

1.6

calculations for DC circuits with varying resistances in combination

1.7

- Kirchhoff calculations:
    - V = I R = voltage drop across any resistor, R
    - V = $\frac{\text{V total x R}}{\text{R total}}$ = voltage drop for resistor R in series
    - V total, total voltage, is equal to the sum of all the voltage drops in the circuit (is equal to zero)

1.8

heat, light, friction, pressure, chemical action, magnetism, motion

1.9

charge storage, smoothing, emergency power, DC block, resonant circuits

1.10

- construction of different types of capacitor
- role played by:
    - conductors
    - dielectric
    - area
    - description of permittivity

1.11

- charge/discharge cycle
- relationship between Q, C & V
- time constant (t=CR)

Learning outcome:

The learner will:

2. Know about direct current power sources and machines

Assessment criteria

The learner can:

2.1 describe the chemical action of primary and secondary cells

2.2 explain the connection of cells and batteries in series and in parallel

2.3 explain the internal resistance of a battery

2.4 describe the magnetic field of a bar magnet

2.5 describe differences in the magnetic characteristics of soft and hard iron

2.6 describe properties and uses of hard and soft magnetic materials

2.7 describe the interaction of a current-carrying conductor in a magnetic field

2.8 explain the production of an EMF by the interaction of a permanent magnet with a coil

2.9 describe the function of the key components of DC generators

2.10 describe the function of the key components of DC motors

Range

2.1

- construction and basic chemical action
- dry cells
- lead acid cells
- nickel-cadmium cells
- other alkaline cells

2.3

basic explanation of internal resistance, effect on battery performance

2.5

flux lines, direction, density

2.6

- hysteresis loop

- remanence
- coercive field
- relative permeability
- demagnetisation quadrant

2.7

Common uses of: permanent magnets, magnetic shielding, electromagnet formers

2.8

- for a single conductor and one field:
    - direction of current and effect on field direction
    - strength of current and effect on field strength

2.9

- definition of electromagnetic induction
- effect on the induced EMF of:
    - number of coils
    - relative speed and direction of movement

2.10

DC generators: armature, magnets, commutator, brushes

2.11

DC motors: armature, magnets, commutator, brushes

Learning outcome:

The learner will:

3. Know the principles of alternating current

Assessment criteria

The learner can:

3.1 explain the term ‘alternating current’

3.2 describe commonly used terms related to alternating current

3.3 describe the functions of the key components of a single-phase ac generator

3.4 explain the difference between single-phase and 3-phase waveforms

Range

3.1

- position of coil relative to magnetic field
- waveform
- direction of flow on graph axis

3.2

cycle, periodic time, peak value, peak-to-peak value, magnitude or amplitude, frequency

average value, RMS value, phase

3.3

2-pole machine, rotating armature, rotating field, armature, slip rings, brushes

Learning outcome:

The learner will:

4. Know about aircraft electrical devices and data transmission

Assessment criteria

The learner can:

4.1 describe thermocouples

4.2 describe the construction and operation of a photo-cell

4.3 describe the operation, application and common uses in aircraft of variable resistors

4.4 potentiometers and rheostats

4.5 explain why data buses are used in aircraft

4.6 explain how light can be transmitted along a fibre optic cable

Range

4.1

description of the materials, construction, operation and use

4.4

data redundancy, weight saving, need for a complex controller

4.5

encode, transmit (including internal reflection), boost, de-code

Unit 208 Principles of welding and fabrication

UAN:	A/507/4066
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit provides the learner with the knowledge and understanding of the principles, methods and technology involved in engineering maintenance using welding and fabrication.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Know different welding and fixing techniques
2. Know the terminology and symbols used within welding
3. Know the effects of welding
4. Know common materials used in fabrication
5. Know the different types and application of fabrication tools

Learning outcome:

The learner will:

1. Know different welding and fixing techniques

Assessment criteria

The learner can:

1.1 describe different types of welding and fixing techniques

1.2 describe the principles and applications of non-fusion joining processes

1.3 describe the principles and applications of the fusion welding processes

Range

1.1

welding and fixing techniques, e.g. temporary fixings (tack welding)

- soldering:
  - brazing
  - spot welding
  - riveting
  - adhesive bonding (e.g. composite bonding films, epoxy resins)
  - mechanical fastenings (bolts, screws)
  - self-securing joints (knock up, panel down, swaged, joggled)

1.2

non-fusion joining processes, e.g. soldering (hard/soft), brazing

1.3

fusion welding processes, e.g. arc welding (MMA), oxyacetylene, spot welding, MIG, MAG, TIG

Learning outcome:

The learner will:

2. Know the terminology and symbols used within welding

Assessment criteria

The learner can:

2.1 describe the features and joint preparation of different types of weld joints

2.2 identify symbols commonly used in accordance with current industry standards

Range

2.1 types of weld joint: butt welds, tee welds, corner welds, lap weld, edge weld, fillet welds

2.2 symbols, e.g. basic weld symbol, symbolic representation of weld, weld symbol, supplementary, symbols, complementary indication, dimensioning welds

Learning outcome:

The learner will:

3. Know the effects of welding

Assessment criteria

The learner can:

3.1 describe types of distortion which can occur when welding and their causes

3.2 describe different types of weld defect which can occur when welding and their causes

3.3 describe the methods used to identify weld distortion and defects

Range

3.1

types of distortion, e.g. longitudinal shrinkage, transverse shrinkage, angular distortion, bowing and dishing, buckling, twisting

3.2

types of defect: porosity weld defect, omitted weld defect, biased weld defect, burn through weld defect, missed weld defect

3.3

- methods:
  - testing (e.g. destructive, non-destructive)
  - checking (e.g. dimensional, visual), quality standards

Learning outcome:

The learner will:

4. Know common materials used in fabrication

Assessment criteria

The learner can:

4.1 describe the different materials and their forms that can be used in fabrication
4.2 outline possible fabrication applications for different types of materials

Range

4.1

- materials:
  - ferrous (low-carbon, medium-carbon, high-carbon and stainless steels)
  - non-ferrous (aluminium/aluminium alloys, brass, copper, titanium/titanium alloys, zinc/zinc alloys)
  - non-metallic (e.g. plastics, rubbers, composites)

Learning outcome:

The learner will:

5. Know the different types and application of fabrication tools

Assessment criteria

The learner can:

5.1 describe the use of hand tools within fabrication applications

5.2 describe the use of machinery and machine tools within fabrication applications

Range

5.1

hand tools: hammers, mallets, bench stakes and mandrels, files, chisels, clamps and grips, spanners, cutting tools, screwdrivers, pliers, saws, formers

5.2

machinery and machine tools: drills, saws, grinders, bending equipment, folding machines, guillotines, up and down stroking press brakes, shears, punches, nibbling machines, steel working tools, CNC variations

Unit 209 Principles of aerospace composite materials

UAN:	F/507/4067
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit aims to provide the learner with knowledge of composite materials for use in current and future aircraft applications.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Understand the composition, properties and application of aerospace composite materials
2. Understand how fibres are produced and used to form aerospace composite structures
3. Know health and safety procedures associated with composite materials in aerospace applications

Learning outcome:

The learner will:

1. Understand the composition, properties and application of aerospace composite materials

Assessment criteria

The learner can:

1.1 describe key materials for composites

1.2 explain the properties of aerospace composite materials

1.3 describe the application of aerospace composite materials

Range

1.1

carbon fibre, glass fibre, aramid fibre, quartz fibre, sandwich materials, laminate materials

1.2

strength/weight ratio, fatigue life, corrosion resistance, conductivity, strength, impact resistance, rapid temperature change

1.3

wing covers, fairings, floorboards, vertical/horizontal stabiliser, spars, ribs

Learning outcome:

The learner will:

2. Understand how fibres are produced and used to form aerospace composite structures

Assessment criteria

The learner can:

2.1 describe how composite fibre materials are used to produce finished components
2.2 outline the importance of fibre arrangement within composite structures
2.3 describe bonding materials used to form matrices
2.4 explain key processes used to form composite structures

Range

2.1

filament, tow, strand, mat, woven fabric, lamina, matrix

2.2

- random fibre arrangement
- unidirectional stack
- woven (plain weave, basket weave)

2.3

epoxy resin, polyester, phenolic, vinyl esters, use of hardeners

2.4

- wet hand lay-up
- pre-preg lay-up
- resin film infusion
- resin transfer moulding
- carbon fibre moulding
- automatic tape laying

Learning outcome:

- The learner will:

3. Know health and safety procedures associated with composite materials in aerospace applications

Assessment criteria

The learner can:

3.1 describe potential hazards and risks associated with the processing of composite materials

3.2 describe potential hazards and risks associated with handling composite materials

3.3 describe safety precautions and procedures used when processing and handling composite materials

Range

3.1

- composite material potential hazards; e.g. corrosive, flammable, toxic, carcinogenic, irritant
- processing
    - personal risk (e.g. ingestion, inhalation, skin damage, allergies)
    - risk to materials (e.g. contaminants, Foreign Object Damage (FOD), water, chemicals)
    - risks to environment (e.g. fire and explosion, contamination)

3.2

- composite material potential hazards; e.g. corrosive, flammable, toxic, carcinogenic, irritant

- handling
    - personal risk (e.g. dust, particulates and fibres, splinters, burns)
    - risks to components (e.g. impact damage, contaminants)

3.3

- Health & Safety legislation, manufacturers information, Codes of Practice, COSHH
- use of Personal Protective Equipment (PPE) (e.g. fume/dust extraction)
- safe disposal of waste
- safe transport
- storage
- hazard signs

Unit 210 Principles of mechanical assembly and fitting

UAN:	J/507/4068
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	The aim of this unit is to provide learners with the knowledge and understanding of mechanical assembly and fitting within manufacturing and maintenance. The unit covers the principles, methods and technology involved in a range of engineering disciplines.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Know the processes that support the mechanical assembly and fitting of engineering components
2. Know about assembling and fitting components safely to engineering equipment
3. Know about the safe use of tools, equipment and measuring instruments to carry out quality checks on assembled engineering equipment

Learning outcome:

The learner will:

1. Know the processes that support the mechanical assembly and fitting of engineering components

Assessment criteria

The learner can:

1.1 describe the uses of engineering drawings and specifications in mechanical assembly and fitting

1.2 describe the processes that support the mechanical assembly and fitting of engineering components

Range

1.1

- uses, e.g visual perspective, technical details, accurately illustrates engineering components

1.2

- supportive processes: e.g support documentation, standards documentation, specifications

Learning outcome:

The learner will:

2. Know about assembling and fitting components safely to engineering equipment

Assessment criteria

The learner can:

2.1 describe how to safely connect/fit given components to engineering equipment
2.2 describe how to safely use tools and relevant assembly methods and techniques to carry out different assembly tasks safely
2.3 describe how to use relevant standards and instructions to check the compliance of an assembly for quality and accuracy

Range

2.1

- electrical/electronic components
    - components, e.g. conduit, trunking, tray type table enclosures, plugs and sockets, sensors, motors, transformers, relays, solenoids, switches, electronic modular units, instrumentation units
    - techniques, e.g. routing cables and wires, mounting/securing components, cable fixings and fasteners, terminating and joining cables/wires using screwed/clamped/soldered/crimped connections
    - use of cable protection devices, e.g. sleeving, grommets
- hydraulic power components
    - components, e.g. motors, pumps, compressors, intensifiers, filters, lubricators, separation units, reservoirs, accumulators, sensors, meters, gauges, indicators

- pipework and connection devices, e.g. manifolds, couplings, laying pipework/cabling/wires
- control components, e.g. valves, actuators, cylinders, regulators

2.2

- fitting, e.g. filing, scraping, lapping, polishing, blue bedding of components, shimming, packing, use of expansion/contraction methods
- securing, e.g. fasteners, threaded devices, bolt locking methods, riveting, soldering, brazing, sealants, adhesives
- use of tools, e.g. drilling, soldering irons, reaming, press tools, hacksaws, files, spanners, screwdrivers, wrenches, sockets, crimping tools, torque wrench, alignment tools
- use of assembly aids and equipment, e.g. work-holding devices, jigs, fixtures, supports, lifting and moving equipment, rollers, wedges
- working within specified timeframes, e.g. estimation time to complete task, working to set times
- maintaining safe working environment, e.g. appropriate and approved assembly techniques used at all times, work area housekeeping, risk assessments
- assembly tasks (sub-assemblies or assemblies), e.g. panel, support framework, casings, hydraulic power, simple electrical circuit, component kits

2.3

- quality checks, e.g. setting working clearance, torque settings, alignment, balancing
- national standards, e.g. British Standards (BS), International Organisation for Standardisation (ISO)
- design standards, e.g. customer standards and requirements, company standards and procedures
- specified instructions, e.g. specific system requirements, operational manuals, manufacturers' instructions

Learning outcome:

The learner will:

3. Know about the safe use of tools, equipment and measuring instruments to carry out quality checks on assembled engineering equipment

Assessment criteria

The learner can:

3.1 describe the uses of engineering drawings and specifications in mechanical assembly and fitting

3.2 describe the processes that support the mechanical assembly and fitting of engineering components

Range

3.1

- appropriateness to assembly task
- health and safety considerations
- relevant regulations and guidance
- permitted operating range

3.2

- hand tools, e.g. hacksaws, files, spanners, screwdrivers, wrenches, sockets, crimping tools
- power tools, e.g. drills, soldering irons, air tools
- equipment: Personal Protective Equipment (PPE); other, e.g. for lifting and moving, jigs, fixtures, supports, wire looms
- measuring instruments, e.g. rule, tape measure, micrometers, gauges, dial test indicators, multimeters, pressure meters

3.3

- quality checks, e.g. completeness, alignment, size, positional accuracy, component security, damage or foreign objects
- engineering equipment that has a range of components e.g.:
    - electrical/electronic – correct inputs/outputs, electrical continuity

- hydraulic power – function, leak and pressure testing, electrical continuity, pipework free from ripples or creases
- sub-assemblies – function, freedom of movement, orientation, operating/working clearances, bearing end float

Unit 211 Principles of Computer Aided Design (CAD)

UAN:	L/507/4069
Level:	2
GLH:	60
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit provides the learner with the knowledge of Computer Aided Design (CAD) software, of how objects are designed in either 2D or 3D and of how these objects are then manufactured.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Know the risks to health and safety associated with the use of computer equipment and associated peripheral devices
2. Know how to configure the CAD system to suit drawing requirements
3. Know the requirement to comply with national and international drawing standards
4. Know how to use CAD software for the production of 2D industry standard engineering drawings
5. Know how to use layers, copy, modify and manipulate drawn entities to maintain drawing efficiency

Learning outcome:

The learner will:

1. Know the risks to health and safety associated with the use of computer equipment and associated peripheral devices

Assessment criteria

The learner can:

1.1 describe the hazards and possible risks associated with the use of Visual Display Unit (VDU) equipment and peripheral devices

1.2 describe the requirements of a suitable working environment relating to the safe use of computer equipment

1.3 outline the requirements of the current Health and Safety (Display Screen Equipment) Regulations

Range

1.1

hazards: electrical hazard, repetitive work, screen glare, excessive VDU use

1.2

requirements: working position, lighting, environment

Learning outcome:

The learner will:

2. Know how to configure the CAD system to suit drawing requirements

Assessment criteria

The learner can:

2.1 outline drawing parameters that can be set by the user during system configuration

2.2 state the benefits and limitations of the use of cad software in comparison to conventional drawing methods

Range

2.1

- drawing parameters: e.g.
  - drawing templates
  - sheet sizes
  - drawing lines and limits
  - scales
  - line types

- text and dimension styles
- screen display
- drawing origin and datum
- drawing layers
- peripheral devices input and output procedures
- customised menus
- units
- toolbars

2.2

- benefits and limitations, e.g.
  - productivity and speed of drawing creation
  - accuracy of drawing components
  - uniformity of production
  - modification/editing
  - storage space required
  - standardised parts, symbols etc.
  - working practices
  - electronic data exchange and transfer
  - finite element analysis
  - set up cost
  - data storage
  - training

Learning outcome:

The learner will:

3. Know the requirement to comply with national and international drawing standards

Assessment criteria

The learner can:

3.1 outline the national and international standards and conventions that relate to engineering drawing practice

3.2 outline the features of a CAD drawing that need to comply with national and international standards

3.3 describe the use of standard symbols and representations used within CAD drawings

Range

3.2

- features: e.g.
  - drawing sheet sizes and layouts
  - projection – first and third angle
  - types of line
  - lettering and numbering
  - dimensioning
  - symbols
  - section cross hatching
  - units
  - abbreviations
  - representation of common features

3.3

symbols, e.g. weld symbols, electrical/electronic symbols, fluid power symbols, mechanical symbols

standard representations, e.g. sketches, schematic diagrams, flow charts, physical layout diagrams, illustrations from manufacturers' manuals

Learning outcome:

The learner will:

4. Know how to use CAD software for the production of 2D industry standard engineering drawings

Assessment criteria

The learner can:

4.1 describe the requirements of drawing datum selection

4.2 describe the different co-ordinate input methods and their uses

4.3 outline types of geometry that can be drawn

4.4 describe the use of drawing aids that are commonly used

4.5 describe methods of adding dimensions and text to drawn geometry to create a working drawing

4.6 outline the benefits of using drawing templates

4.7 describe the types of device available to produce hard copy of the completed drawing

4.8 outline the importance of saving partial or completed drawings at appropriate intervals

Range

4.1

requirements: reference point, ease of use, compatibility

4.2

Co-ordinate input methods: absolute, relative/incremental, polar

4.3

geometry, e.g. lines, circles, arcs, ellipses

4.4

- drawing aids, e.g.
  - coordinate grids and snaps

- object snaps
- viewing features (e.g. zoom, previous, pan)

4.5

- dimensions:
  - linear dimensions
  - radial dimensions
  - angular dimensions
  - leaders dimensions
  - text dimensions
  - tolerances dimensions
- text:
  - text location
  - font type
  - size and orientation

Learning outcome:

The learner will:

5. Know how to use layers, copy, modify and manipulate drawn entities to maintain drawing efficiency

Assessment criteria

The learner can:

5.1 describe how to set-up different layers and typical uses

5.2 describe the attributes of entities that can be edited or modified

5.3 outline drawing commands by which entities can be modified/manipulated to aid drawing efficiency

Range

5.1

layers: layer definition, layer management

5.2

attributes: size, position, orientation

5.3

drawing commands: scaling, mirroring, rotating, trimming, moving/translating, corner filleting/chamfering, exploding, copying, arrays/patterns, extending, stretching, erasing

Unit 301 Human factors and behaviours in aviation

UAN:	H/507/4059
Level:	3
GLH:	90
Endorsement by a sector or regulatory body:	This unit is endorsed by the Aerospace Apprenticeship Employer Group
Aim:	This unit provides the learner with the knowledge of the factors that influence staff working within the aviation industry, including human and personal factors and social psychology. This unit also covers features and limitations of human performance and how performance is affected by physical/external aspects of the working environment. The learner will also gain knowledge of carrying out risk assessment activities related to different types of tasks to minimise errors and put in place safe working practices.
Assessment type	Short-answer question assessment

Learning outcomes

In this unit, the learner will:

1. Understand why human factors are important in aviation
2. Understand features and limitations of human performance
3. Understand aspects of social psychology
4. Understand personal factors that affect human performance
5. Understand how physical aspects of the working environment affect human performance
6. Understand how categories of tasks can affect human performance
7. Understand communication in the workplace
8. Understand error models within aeronautical engineering
9. Understand risk assessments in aeronautical engineering environments

Learning outcome:

The learner will:

1. Understand why human factors are important in aviation

Assessment criteria

The learner can:

1.1 explain the term ‘human factors’ in aviation

1.2 state the reasons why human factors are important in the aeronautical engineering workplace

1.3 state the categories of human factors that are important to aeronautical engineering staff

Range

1.1

meaning of the term and how it is used in aviation (SHEL Model, Murphy’s Law, anthropometry, Dirty Dozen, ergonomics)

1.2

- safety of employees, passengers, people on the ground etc.
- safety of assets (eg: aircraft, equipment etc.)
- long-term health of employees
- efficiency of the organisation

1.3

working environment, work patterns, social habits, workload, communication, employee health

Learning outcome:

The learner will:

2. Understand features and limitations of human performance

Assessment criteria

The learner can:

2.1 explain how images are seen and interpreted by humans

2.2 explain how sounds are heard and interpreted by humans

2.3 explain how human memory can become limited

2.4 state the factors that affect mental attention span

2.5 describe effects on human performance and behaviour of degraded eyesight and hearing

2.6 explain how working in challenging environments presents risk to personal safety and airworthiness

Range

2.1

- main parts of the eye
- how each part of the eye reacts to light
- rods and cones
- seeing in high and low light
- peripheral vision
- interpretation by the brain

2.2

- main parts of the ear
- vulnerable parts of the ear
- effect of noise – percussive, prolonged high intensity, varying pitch
- Noise Induced Hearing Loss (NIHL)

2.3

- time from exposure to information

- form that information is in (audio, visual, words, pictures etc.)
- fatigue
- age
- complexity of information
- artificial stimulants/depressants
- stress
- low motivation
- poor health
- types (iconic, echoic, episodic, semantic)

2.4

- overconfidence
- boredom
- fatigue
- complexity of information
- artificial stimulants/depressants

2.5

- individually and in combination (such as in older people)
- sight eg: long and short sight, optical illusion including the strobe effect, persistence, moving
- from light area to work in the dark, optimum lighting for typical tasks, use of spectacles
- and magnifiers
- hearing eg: high and low tone deafness, tinnitus, hearing damage, poor communication
- social isolation (at work and at home)

2.6

- at height and in confined spaces eg: claustrophobia, fear of heights, limited access/egress to a
- large space

- uncomfortable climate
- specific tasks (eg: inspections on fuselage crown or in equipment bays)
- low concentration
- rushing the task
- cutting corners
- poor vision

Learning outcome:

The learner will:

3. Understand aspects of social psychology

Assessment criteria

The learner can:

3.1 explain areas of individual and group responsibility in aerospace engineering environments

3.2 explain motivation and de-motivation

3.3 explain 'peer pressure' and its effects

3.4 describe how company culture can compromise best working practices

3.5 explain concepts of team working

3.6 explain the primary responsibilities of engineering managers and supervisors

3.7 describe the basic concepts of leadership

Range

3.1

- outline of a typical organisation (must include aviation maintenance)
- typical roles and responsibilities
- individuals and groups or teams
- individual responsibility when working alone and within a team
- group or team responsibilities
- overview of group and inter-group dynamics (eg: rivalry, polarisation, 'social loafing')

3.2

- fulfilling individual needs
- Maslow's Hierarchy of Needs
- Herzberg Satisfaction Theory
- individual motivation
- motivation by management

- characteristics of motivation and de-motivation
- how they can be affected by internal and external factors eg: management decisions, staffing and resources, workload (very high or very low), organisational culture, personal situation

3.3

- conformity and non-conformity
- pressure from co-workers, not management
- advice and pressure from more experienced colleagues to adopt particular work practices
- how it can affect performance of maintenance tasks

3.4

- overview of different types of culture (eg: safety, organisational, shift, team, social, individual etc.)
- time constraints (“can do” culture, “press-on-itis”)

3.5

- what is a team?
- advantages and disadvantages of team working
- Belbin team theory
- team identity
- working with other teams
- ownership of tasks
- communication
- co-operation
- mutual support

3.6

- difference between management and supervisor roles
- what should an employee expect from a supervisor? (eg motivation,
- support, guidance etc.)
- engineering organisations (eg: part145, military maintenance organisation

3.7

- what is a leader?
- different leadership styles (autocratic/democratic)
- the basic characteristics of a leader
- how and when any individual might provide leadership eg: passing on knowledge and experience to colleagues
- organising and directing group tasks
- inspection and reporting on the work of others

Learning outcome:

The learner will:

4. Understand personal factors that affect human performance

Assessment criteria

The learner can:

4.1 explain the effects that personal health and fitness have on work performance

4.2 explain sources and types of stress and the effects within a working environment

4.3 explain effects of setting time deadlines on individual work performance

4.4 explain the concept of work overload and underload

4.5 explain the effects of shift work on sleep and fatigue

4.6 explain the effects of alcohol, medication and substance abuse and how it affects individual work performance

4.7 explain the personal legal obligations of individuals working in the aerospace industry

4.8 explain the importance of maintaining individual professional currency

Range

4.1

- legal requirement for individual physical and mental fitness while at work
- types of medical condition that might affect work eg:
- minor illness (eg: cold, ‘flu, sickness etc.)
- major physical illness (eg: heart attack, stroke, cancer etc.)
- mental illness (eg: depression etc.)
- minor physical injury (eg: sprained wrist, pulled muscle, cramp etc.)
- major physical injury (eg: broken bones, lacerations etc.)
- effects of toxins and other substances (eg: carbon monoxide, alcohol, drugs etc.)
- gradual deterioration in physical condition

4.2

- define ‘stress’ (eustress, distress, acute stress, chronic stress, hypo stress, hyper stress)
- sources: home (eg: family illness, divorce etc.); work (organisational, task related)
- types: acute and chronic stress
- signs of stress (physical, health, behaviour, cognitive, other)
- explanation of how stress can affect individual performance at work

4.3

- actual, perceived and self-imposed deadlines
- effects of time pressure and deadlines
- managing time pressure and deadlines

4.4

- definition of work overload and underload
- results of work overload and underload
- factors determining workload
- workload management

4.5

- what is sleep?
- five stages of sleep
- circadian rhythms
- fatigue (causes, symptoms)
- working at night
- types of shift pattern

4.6

- removal of alcohol from the blood
- effects while fatigued, hungry or combined with medication
- types, effects, short and long term consequences of abuse of: alcohol, prescription medication, over-the-counter medication, illegal drugs
- effects on individual work performance

4.7

- alcohol limits and legal requirements for aircraft engineers
- CAP 562/AN47
- transport legislation/AN45
- health and safety legislation
- legal requirements for hearing protection
- correct protection for frequency range.

4.8

- refresher training
- reading briefing material
- notices and amendments to maintenance procedures
- reading professional journals
- undertaking up-skilling and further licence training

Learning outcome:

The learner will:

5. Understand how physical aspects of the working environment affect human performance

Assessment criteria

The learner can:

5.1 explain the effects of noise on individuals and groups

5.2 explain the effects of fumes on individual performance

5.3 explain the effects of varying illumination on individual performance

5.4 explain the effects of variations in climate on individual performance

5.5 explain the effects of exposure to constant motion and vibration while working

5.6 explain the effects of layout of a working environment on individual performance

Range

5.1

effects on e.g: concentration, communication

5.2

effects on e.g: concentration, communication, longer term effects, safe oxygen levels

5.3

- effects eg:
  - ability to see detail
  - moving between areas of different illumination, including well-lit hangar and night flight line
  - strobe effect and propellers

5.4

variations, eg: cold/wet, warm/dry, hot/humid environments

5.5

- exposure to constant motion and vibration eg:
  - Working at height on scissor platforms and cherry picker
  - Unsteady platforms
  - Use of rotating or percussive tools

5.6

- layout, eg:
  - the three components of a working environment: layout, cleanliness, ease of movement between work areas
  - lighting, noise, atmosphere, temperature etc.
  - social environment
  - tasks, tools and information

Learning outcome:

The learner will:

6. Understand how categories of tasks can affect human performance

Assessment criteria

The learner can:

6.1 explain the importance of planning the execution of a task

6.2 explain the effects of physically demanding work on individual performance

6.3 explain the effects of repetitive tasks on individual performance

6.4 explain aspects of visual inspection

6.5 explain aspects of working on complex systems

Range

6.1

planning eg: defining the task, defining the resources, personal skills and proficiency, information

6.2

- effects relating to, eg:
  - health and physical condition, effects of age
  - work environment
  - physical effort

6.3

- effects relating to, eg:
  - ignoring manuals, job cards etc.
  - complacency
  - making assumptions

6.4

- requirements for visual inspection, eg:
  - importance of good eyesight
  - knowledge of the inspection area

- illumination
- concentration
- systematic search

6.5

- aspects , eg:
  - simple system: transparent to the engineer
  - complex system: opaque to the engineer
  - clear understanding of the purpose of the system
  - system-specific training
  - pooling of knowledge and skills
  - clear and comprehensive information and guidance.

Learning outcome:

The learner will:

7. Understand communication in the workplace

Assessment criteria

The learner can:

7.1 explain the importance of good communication in the workplace

7.2 explain the importance of accurate work logging

7.3 explain modes of communication between individuals and teams

7.4 explain the importance of information dissemination.

Range

7.1

- within and between groups eg: prevention of accidents
- maintaining good working relations
- organisational efficiency

7.2

accurate work logging, eg: formal work logging, shift logging, shift handover, task staging, duplicate, inspection stage sheets/check

7.3

communication, eg: verbal, written, body language, workplace social culture,

communication between all levels of an organisation

Learning outcome:

The learner will:

8. Understand error models within aeronautical engineering

Assessment criteria

The learner can:

8.1 explain the error models and theories used in aeronautical engineering

8.2 explain types of error that occur during work on aircraft

8.3 describe the error-incident-accident chain

8.4 describe methods of managing and avoiding errors

Range

8.1

error models, eg induced, variable, reversible/irreversible, slips, lapses and mistakes, the ‘swiss cheese model’

8.2

- types or error, eg:
  - complacency
  - environmental capture
  - rule-based errors
  - violations
  - individual practices and habits
  - errors associated with visual inspection

- latent/active errors

8.3

error-incident-accident chain, eg: self-discipline, safety management system, anonymous and blame-free reporting, training, logging and analysis

Learning outcome:

The learner will:

9. Understand risk assessments in aeronautical engineering environments

Assessment criteria

The learner can:

9.1 define the terms associated with risk assessment

9.2 describe the five steps to risk assessment

9.3 describe the associated risks for workplace hazards

9.4 describe conclusions from risk assessments

9.5 explain how to manage workplace emergencies

Range

9.1

hazard, risk, severity, likelihood (probability)

9.2

Steps:

1 - Identify hazards

2 - Decide who might be harmed and how

3 - Evaluate risks and decide on precautions

4 - Record findings and implement them

5 - Review and update

9.4

Steps 2 and 3: recommend ways of eliminating or reducing to an acceptable level, a range of identified risks

9.5

- Steps 3 and 4: reduce the likelihood of them happening
    - policies, procedures, regular training
    - management of workplace emergency situations such as fire, spillage, personal injury etc.

Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centre document library** on **www.cityandguilds.com** or click on the links below:

Centre Handbook: Quality Assurance Standards

This document is for all approved centres and provides guidance to support their delivery of our qualifications. It includes information on:

- centre quality assurance criteria and monitoring activities
- administration and assessment systems
- centre-facing support teams at City & Guilds/ILM
- centre quality assurance roles and responsibilities.

The Centre Handbook should be used to ensure compliance with the terms and conditions of the centre contract.

Centre Assessment: Quality Assurance Standards

This document sets out the minimum common quality assurance requirements for our regulated and non-regulated qualifications that feature centre-assessed components. Specific guidance will also be included in relevant qualification handbooks and/or assessment documentation.

It incorporates our expectations for centre internal quality assurance and the external quality assurance methods we use to ensure that assessment standards are met and upheld. It also details the range of sanctions that may be put in place when centres do not comply with our requirements or actions that will be taken to align centre marking/assessment to required standards. Additionally, it provides detailed guidance on the secure and valid administration of centre assessments.

Access arrangements: When and how applications need to be made to City & Guilds provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **Centre document library** also contains useful information on such things as:

- conducting examinations
- registering learners
- appeals and malpractice.

Useful contacts

Please visit the **Contact us** section of the City & Guilds website.

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