QUALIFICATION HANDBOOK

Level 3 Diploma in Aircraft Manufacture (4597)

September 2012 Version 1.1

City & Guilds

Qualification at a glance

Subject area	Engineering
City & Guilds number	4597-31/32/33/34/35
Age group approved	16-18, 19+
Entry requirements	Level 2
Assessment	Assignment, e-assessment
Fast track	Available
Support materials	Centre handbook
Registration and certification	Consult the City & Guilds website for information

Title and level	City & Guilds number	Accreditation number
Level 3 Diploma in Aircraft Manufacture (Mechanical Manufacture)	4597-31	600/1925/6
Level 3 Certificate in Aircraft Manufacture (Composites Assembly)	4597-32	600/1924/4
Level 3 Diploma in Aircraft Manufacture (Electrical and Avionics Manufacture)	4597-33	600/1932/3
Level 3 Certificate in Aircraft Manufacture	4597-34	600/1967/0
Level 3 Diploma in Aircraft Manufacture	4597-35	600/1968/2

Version and date	Change detail	Section
1.1 Sep 2012	Correct unit 007 title in Structure	**Structure**

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1 Introduction

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

Area	Description
Who are the qualifications for?	For candidates who work or want to work in the Aircraft Manufacturing sector and/or with composite materials. A pathway has been developed specifically for CPD use in composite materials.
What do the qualifications cover?	Candidates will learn, develop and practise the skills required for employment and/or career progression in the Aircraft Manufacturing sector.
Are the qualifications part of a framework or initiative?	Diploma sized pathways are recognised as technical certificates in the Engineering Manufacture Level 3 Apprenticeship framework
What opportunities for progression are there?	Candidates may progress into employment or to the following City & Guilds qualifications: • Level 3 NVQ Diploma in Aerospace Engineering • Level 3 Diploma in Aircraft Maintenance • Level 3 Diploma in Survival Equipment • Institute of Leadership and Management (ILM) team leadership qualifications.

Structure

Learners require a total of 62 credits from the following mandatory units to achieve the **Level 3 Diploma in Aircraft Manufacture (Mechanical Manufacture) (4597-31)**.

Mandatory Units

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
D/503/1128	Unit 001	Aviation Mathematics and Science for Technicians	8
T/503/1281	Unit 002	Civil Manufacturing Legislation in Aviation	4
D/503/0965	Unit 003	Aerodynamics and Control in Fixed-Wing Aircraft	5
M/503/1263	Unit 004	Human Factors in Aviation	5
L/503/1271	Unit 005	Aircraft Manufacture	9
H/503/1289	Unit 007	Mechanical Systems in Aircraft	12
R/503/0977	Unit 008	Structural Materials and Components in Aircraft	9
R/503/1272	Unit 009	Manufacturing Aircraft Structures	10

Learners require a total of 25 credits from the following mandatory units to achieve the **Level 3 Certificate in Aircraft Manufacture (Composites Assembly) (4597-32)**.

Mandatory Units

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
M/503/1263	Unit 004	Human Factors in Aviation	5
A/503/1282	Unit 013	Fundamentals of Aircraft Composite Materials	2
J/503/1284	Unit 017	Manual Drilling of Aircraft Composite Materials	4
L/503/1285	Unit 019	Installing Shims in Aircraft Composite Structures	4
R/503/1286	Unit 020	Installing Fasteners in Aircraft Composites	4
Y/503/1287	Unit 022	Non-destructive Testing of Aircraft Composites	6

Learners require a total of 60 credits from the following mandatory units to achieve the **Level 3 Diploma in Aircraft Manufacture (Electrical and Avionics Manufacture) (4597-33)**.

Mandatory Units

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
D/503/1128	Unit 001	Aviation Mathematics and Science for Technicians	8
T/503/1281	Unit 002	Civil Manufacturing Legislation in Aviation	4
D/503/0965	Unit 003	Aerodynamics and Control in Fixed-Wing Aircraft	5

M/503/1263	Unit 004	Human Factors in Aviation	5
A/503/0956	Unit 006	Fundamentals of Electronics and Avionics	10
Y/503/1273	Unit 010	Electronic and Further Electronic Fundamentals	9
D/503/1274	Unit 011	Aircraft Electrical Systems	10
M/503/1280	Unit 012	Installing Aircraft Electrical Cables	9

Learners require a minimum of 13 credits from the following units, of which a minimum of 7 credits must be at Level 3 to achieve the **Level 3 Certificate in Aircraft Manufacture (4597-34)**.

Learners require a minimum of 37 credits from the following units, of which a minimum of 19 credits must be at Level 3 to achieve the **Level 3 Diploma in Aircraft Manufacture (4597-35)**.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
D/503/1128	Unit 001	Aviation Mathematics and Science for Technicians	8
T/503/1281	Unit 002	Civil Manufacturing Legislation in Aviation	4
D/503/0965	Unit 003	Aerodynamics and Control in Fixed-Wing Aircraft	5
M/503/1263	Unit 004	Human Factors in Aviation	5
L/503/1271	Unit 005	Aircraft Manufacture	9

A/503/0956	Unit 006	Fundamentals of Electronics and Avionics	10
H/503/1289	Unit 007	Mechanical Systems in Aircraft	12
R/503/0977	Unit 008	Structural Materials and Components in Aircraft	9
R/503/1272	Unit 009	Manufacturing Aircraft Structures	10
Y/503/1273	Unit 010	Electronic and Further Electrical Fundamentals	9
D/503/1274	Unit 011	Aircraft Electrical Systems	10
M/503/1280	Unit 012	Installing Aircraft Electrical Cables	19
A/503/1282	Unit 013	Fundamentals of Aircraft Composite Materials	2
J/503/1284	Unit 017	Manual Drilling of Aircraft Composite Materials	4
L/503/1285	Unit 019	Installing Shims in Aircraft Composite Structures	4
R/503/1286	Unit 020	Installing Fasteners in Aircraft Composites	4
Y/503/1287	Unit 022	Non-destructive Testing of Aircraft Composites	6

2 Centre requirements

Approval

Current centres

Centres that have been delivering City & Guilds 2661 level 3 Certificate in Aeronautical engineering pathways 03 and 04 (Aero Manufacturing) will be automatically approved to run the non composite pathways within this qualification and need take no action.

City & Guilds centres running other qualifications, and any wishing to deliver the composite materials route will need to submit a qualification approval form. This requirement for the composite materials pathway has been made to ensure centres have the appropriate equipment and trained staff to properly assess learners in this high technology area.

New centres

Training providers not currently registered as City & guilds centres that wish to deliver this qualification should contact their local regional office to initiate centre approval. To identify their nearest office, potential centres can call the centre support team number at the end of this document or through our website at **www.cityandguilds.com**.

Resource requirements

Physical resources and site agreements

Centres can use specially designated areas within a centre to assess, for example, the installation of specialised electrical systems, alignment and setting up of electric motors and driven devices (pumps, compressors, and generators). The equipment, systems and machinery must meet industrial standards and be capable of being used under normal working conditions, for example electric motors must have a method of applying sufficient power and not be connected up to show movement.

Please note that to gather the requisite evidence, access to flight worthy aircraft is required on a regular basis.

Centre staffing

Centre staff must satisfy the requirements for occupational expertise for this qualification.

These requirements are as follows:

- Staff should be technically competent in the areas for which they are delivering training and/ or should also have experience of providing training.
- 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 areas 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.

Centre staff may undertake more than one role, e.g. tutor and assessor or internal verifier, but cannot internally verify their own assessments.

Assessors and internal verifiers

While the Assessor/Verifier (A/V) units are valued as qualifications for centre staff, they are not currently a requirement for the qualification.

Continuing Professional Development (CPD)

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification

Verifier Requirements (internal and external)

Internal quality assurance (Internal Verification) must be carried out by competent Verifiers that as a minimum must hold the QCF Level 4 Award in the Internal Quality Assurance of Assessment Processes and Practices. Current and operational Internal Verifiers that hold internal verification units V1 or D34 will not be required to achieve the QCF Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External quality assurance **(External Verification)** must be carried out by competent External Verifiers that as a minimum must hold the QCF Level 4 Award in the External Quality Assurance of Assessment Processes and Practices**.** Current and operational External Verifiers that hold external verification units V2 or D35 will not be required to achieve the QCF Level 4 Award as they are still appropriate for the verification requirements set out in this Unit Assessment Strategy. Verifiers must be familiar with, and preferably hold, either the nationally recognised Assessor units D32 and/or D33 or A1 and/or A2 or the QCF Level 3 Award in Assessing Competence in the Work Environment.

External and Internal Verifiers will be expected to regularly review their skills, knowledge and understanding and where applicable undertake continuing professional development to ensure that they are carrying out workplace Quality Assurance (verification) of Assessment Processes and Practices to the most up to date National Occupational Standards (NOS) Verifiers, both Internal and External, will also be expected to be fully conversant with the terminology used in the QCF NVQ units against which the assessments and verification are to be carried out, the appropriate Regulatory Body's systems and procedures and the relevant Awarding Organisation's documentation.

Candidate 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 so should have the opportunity to gather work based evidence.

The SEMTA Engineering Manufacture apprenticeship framework suggests that employers would be interested in candidates that:

- Are keen and motivated to work in an engineering environment
- Are willing to undertake a course of training both on-the-job and off-the-job and apply this learning in the workplace
- Have previous work experience or employment in the sector
- Have completed a 14 to 19 Diploma in Engineering or Manufacturing
- Have completed a Young Apprenticeship in Engineering or other related area
- Have GCSEs in English, Maths and Science
- Have completed tests in basic numeracy, literacy and communication skills and have spatial awareness.

As a guide, the Engineering Manufacturing framework is suitable for applicants who have five GCSEs grades D to E in English, Maths and Science. The selection process on behalf of employers may include initial assessment where applicants will be asked if they have any qualifications or experience that can be accredited against the requirements of the apprenticeship. They may also be required to take tests in basic numeracy and literacy, communications skills and spatial awareness. There may also be an interview to ensure applicants have selected the right occupational sector and are motivated to become an apprentice, as undertaking an apprenticeship is a major commitment for both the individual and the employer.'

Recognition of Prior Learning

Without evidence of formal qualifications, candidates must demonstrate adequate prior knowledge and experience to ensure they have the potential to gain the qualifications. It is recognised that learners come from a wealth of applicable backgrounds and in these cases it is recommended that the centre assess learner competence against their claims.

Age restrictions

There is no age restriction for these qualifications unless this is a legal requirement of the process or the environment.

3 Delivering the Qualification

Initial assessment and induction

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

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

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

Support materials

The following resources are available for these qualifications:

Description	How to access
Centre devised forms	**www.cityandguilds.com**, 4597 qualification pages
Centre devised generic guidance: • Centre guidance • Generic grading criteria	**www.cityandguilds.com**, 4597 qualification pages
Guidance for producing centre devised tasks (specific guidance for each unit within a pathway)	**www.cityandguilds.com**, 4597 qualification pages
Example assignments (for selected units only)	**www.cityandguilds.com**, 4597 qualification pages

4 Assessment

Assessment of the qualification

This qualification is assessed by a combination of e-assessments (multiple choice tests) and centre devised assignments covering practical skills and underpinning knowledge. The table below provides details on the assessment methods for each unit.

Mandatory Units

City & Guilds unit number	Unit title	Assessment method
Unit 001	Aviation Mathematics and Science for Technicians	e-assessment
Unit 002	Civil Manufacturing Legislation in Aviation	Centre Devised Assignment
Unit 003	Aerodynamics and Control in Fixed-Wing Aircraft	e-assessment
Unit 004	Human Factors in Aviation	e-assessment
Unit 005	Aircraft Manufacture	Centre Devised Assignment
Unit 006	Fundamentals of Electronics and Avionics	e-assessment
Unit 007	Mechanical Systems in Aircraft	Centre Devised Assignment
Unit 008	Structural Materials and Components in Aircraft	Centre Devised Assignment
Unit 009	Manufacturing Aircraft Structures	Centre Devised Assignment
Unit 010	Electronic and Further Electrical Fundamentals	Centre Devised Assignment
Unit 011	Aircraft Electrical Systems	Centre Devised Assignment
Unit 012	Installing Aircraft Electrical Cables	Centre Devised Assignment

City & Guilds unit number	Unit title	Assessment method
Unit 013	Fundamentals of Aircraft Composite Materials	e-assessment
Unit 017	Manual Drilling of Aircraft Composite Materials	Centre Devised Assignment
Unit 019	Installing Shims in Aircraft Composite Structures	Centre Devised Assignment
Unit 020	Installing Fasteners in Aircraft Composites	Centre Devised Assignment
Unit 022	Non-destructive Testing of Aircraft Composites	Centre Devised Assignment

Online multiple-choice assessments
The online multiple-choice assessments for this qualification will be in the form of a question with three options to choose from (a, b, c) and calculators are **not** permitted. This is to bring it in line with the CAA exams and the expectation from industry that candidates can do basic mathematics (including long division) without a calculator. Please refer to the 2675-001 sample questions to understand the level of maths required of candidates – this will be available to download from the City & Guilds website.

Centre set assignments
Centres must refer to '*Developing assignments – guidance for centres*' and the associated assignment development forms which are available to download from **www.cityandguilds.com**.

Example assignments and specific assessment guidance for each unit is also available for this qualification and can be found on **http://www.cityandguilds.com**.

Approval process for centre set assignments
Centre set assignments must be approved by the external verifier before use. For each assignment, the *Assignment Sign Off Sheet* (AD3) must be completed and be made available to the EV for inspection.

Time constraints

Timings for e-assessments are indicated in the test specifications on pages 16-18

The centre set and marked assignments will need to have some limits to the time available. The time available may be based on practicalities such as scheduling marking during the required period, but the time available must always be sufficient for candidates to tackle the task fairly, and candidates will be able to negotiate extra time in appropriate circumstances.

Test specifications

Test 1: Unit 001 Aviation mathematics and science for technicians
Duration: 105 minutes

Outcome	Number of questions	%
01 Be able to use principles of arithmetic	8	11.5
02 Be able to use SI, Imperial and US customary units	6	8.6
03 Be able to manipulate algebraic expressions and formulae using standard techniques	7	10
04 Be able to calculate physical properties of common two and three dimensional shapes	5	7
05 Be able to use graphs to determine values and solve engineering problems	6	8.6
06 Understand the nature of matter	8	11.4
07 Understand principles of statics	9	12.9
08 Understand principles of linear, angular and oscillating motion related to aircraft in flight	8	11.4
09 Understand principles of dynamics related to aircraft in flight	7	10
10 Understand principles of fluid motion related to aircraft in flight.	4	5.7
Total	**40**	**100**

Test 2: Unit 003 Aerodynamics and control in a fixed-wing aircraft
Duration: 90 minutes

Outcome	Number of questions	%
01 Know the basic properties of the Earth's atmosphere	4	7
02 Understand the nature of airflow around aerodynamic bodies	13	22
03 Understand the characteristics of the basic wing planforms	4	6
04 Understand the principles of aircraft control	9	15

05 Understand the principles of aircraft stability	7	12
06 Understand the purpose and operation of secondary flying control surfaces	10	16
07 Understand methods of balancing and trimming control surfaces	6	10
08 Understand the basic theory of high speed flight	7	12
Total	**60**	**100**

Test 3: Unit 004 Human Factors in Aviation
Duration: 60 minutes

Outcome	**Number of questions**	**%**
01 Understand why human factors are important in aviation	2	5
02 Know features of human performance	6	15
03 Know aspects of social psychology	6	15
04 Know personal factors that affect human performance	6	15
05 Know physical aspects of working environments that affect human performance	5	12.5
06 Know categories of task that can affect human performance	5	12.5
07 Understand communication in the workplace	3	7.5
08 Understand how human error occurs	3	7.5
09 Know hazards and risks in aeronautical engineering environments	4	10
Total	**40**	**100**

Test 4: Unit 006 Fundamentals of electronics and avionics
Duration: 90 minutes

Outcome	**Number of questions**	**%**
01 Understand the principles of electrical current and charge	9	15

02 Understand the principles of aircraft electrical power generation	8	13
03 Understand the principles and uses of aircraft batteries	7	12
04 Understand the use of aircraft cables and associated devices	8	13
05 Understand aircraft cabling tasks	1	2
06 Understand aircraft power supplies	7	12
07 Understand aircraft flight instruments and lighting systems	7	12
08 Understand digital aircraft control and monitoring systems	13	22
Total	**60**	**100**

Test 5: Unit 013 Fundamentals of Aircraft Composite Materials
Duration: 45 minutes

Outcome	**Number of questions**	**%**
01 Know the meaning and application of aircraft composite materials	9	30
02 Know how fibres are produced and used to form aircraft composite structures	16	53
03 Know safety procedures associated with composite materials in aircraft applications	5	16
Total	**30**	**100**

5 Units

Availability of units

Structure of units

These units each have the following:

- City & Guilds unit number
- Unit Accreditation Number (UAN)
- Level
- Credit value
- Recommended Guided Learning Hours (GLH)
- Relationship to NOS, other qualifications and frameworks
- Endorsement by a sector or other appropriate body
- Unit aim(s)
- Learning outcomes which are comprised of a number of assessment criteria
- Notes for guidance.

Unit 001 Aviation mathematics and science for technicians

UAN:	D/503/1128
Level:	3
Credit value:	8
GLH:	70
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 005, 052.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner the maths and science knowledge in an aviation context to allow further study of aircraft manufacturing and maintenance practices.

Learning outcome
The learner will: 1. be able to use principles of arithmetic
Assessment criteria
The learner can: 1.1 define arithmetical terms 1.2 use standard operators on arithmetical expressions 1.3 calculate the LCM and HCF of arithmetical expressions 1.4 use basic operators on fractions 1.5 convert between fraction, decimal and percentage values 1.6 simplify fractions by cancelling 1.7 distinguish between ratio and proportion 1.8 calculate percentage values for common engineering variables 1.9 calculate by manipulating simple arithmetic ratios 1.10 distinguish between direct and inverse proportion 1.11 calculate the constant of proportionality for arithmetical expressions 1.12 define types of decimal values 1.13 distinguish between 'significant figures' and 'decimal places' 1.14 convert numbers to standard form 1.15 manipulate arithmetic expressions in standard form 1.16 estimate values for expressions involving decimal values

Range
List1 positive negative real numbers **List2** Add Subtract Multiply Divide first degree expressions in an aeronautical context **List3** Expressions with at least four component values **List4** basic rules of fractions proper fractions improper fractions **List5** Standard fractions found in engineering (e.g. imperial sizes) Non-standard 'awkward' fractions Proper fractions improper fractions **List6** proper fractions improper fractions **List8** Engine thrust Voltage variation Fuel tank contents **List12** Recurring Terminating Non-terminating **List13** Definitions and examples **List14** Using more complex expressions than in '2.' with all basic operators **List15**

Rules of estimation Practice with and without calculator The implications of erroneous estimation in an engineering context

Learning outcome
The learner will: 2. be able to use SI, Imperial and US customary units
Assessment criteria
The learner can: 2.1 define the base SI units of measurement 2.2 define the base Imperial units of measurement 2.3 convert base and derived units between Imperial, US Customary and SI units 2.4 calculate derived unit conversion factors using base units 2.5 explain the terms 'relative error' and 'absolute error' 2.6 apply error arithmetic to experimental data 2.7 convert aircraft fuel loads between US Customary, Imperial and SI units 2.8 convert system pressures between Imperial and SI units 2.9 extract data from analogue and digital system gauges

Range
List1 Metre Kilogram Second Ampere Kelvin Pascal Newton Joule Names and symbols for prefixes: Giga G) mega (M) kilo (k) nano (n) pico (p) **List2** Foot (ft) pound (lb) minute (min) Fahrenheit (F) **List3** Derived SI units Hertz Newton

Pascal
Joule
Watt
Volt
Ohm
°Celsius
Kelvin

Compound derived units:
Metres per second
Newton metre

US Customary measures

US gallons

Imperial
Feet
Inches
Yards
pounds (lb)
Imp gallons,

List4
arithmetical means and standard reference ror Imperial and SI systems

tables
graphs
calculators

List5
Explanation of the definition
Using suitable examples from engineering

List6
Relevant to engineering
Tolerance

List7
Pounds
Kilograms
Litres
imperial gallons
US gallons

List8

Pascal
Bar
Atmosphere

Psi
Nm-2

List9
Pounds
Kilograms
Litres
US gallons

aircraft and refueler fuel gauges
aircraft system pressure gauges
ground support system pressure gauges

Learning outcome
The learner will: 3. be able to manipulate algebraic expressions and formulae using standard techniques
Assessment criteria
The learner can: 3.1 factorise algebraic expressions 3.2 use 'algebraic expression', 'equation' and 'identity' 3.3 simplify expressions containing brackets, powers and roots 3.4 solve simultaneous equations 3.5 solve second degree equations 3.6 evaluate aeronautical and scientific formulae by substituting data 3.7 use formulae to obtain engineering and scientific data

Range
List1 By grouping and extracting common factors **List2** Basic definitions with examples **List3** BODMAS nested brackets Indices powers Negative indices fractional indices **List4** Simple equations using basic methods **List5** With one unknown

List6
Gas laws
Aircraft weighing
Aircraft loading (C of G etc)

List7
specific gravity
Pressure
Temperature
heat

Learning outcome
The learner will: 4. be able to calculate physical properties of common two and three dimensional shapes
Assessment criteria
The learner can: 4.1 define the components of a circle 4.2 solve problems related to dimensions of a circle 4.3 create geometrical constructions 4.4 use coordinate systems 4.5 use formulae to calculate dimensions of plane figures 4.6 use formulae to calculate surface area and volume of common solids.

Range
List1 Radius Diameter Circumference Arc Chord **List2** Radius Diameter Circumference **List3:** Triangle Square Rectangle Parallelogram Circle **List4** Rectangular

Polar

List5
Using:
Sine, cosine and tangent relationships
Triangle
Square
Rectangle
Parallelogram

List 6
Cube
Cylinder
Cone
Sphere

Learning outcome
The learner will: 5. be able to use graphs to determine values and solve engineering problems
Assessment criteria
The learner can: 5.1 select scales and origins for graph axes 5.2 extract values from graphs 5.3 extrapolate linear graphs to determine x and y intercepts 5.4 determine y, x, m and c from linear equations and graphs 5.5 solve graphically pairs of simultaneous equations 5.6 recognise graphical representations of sine and cosine waveforms 5.7 determine data values from graphs and tables 5.8 apply graphical techniques to the solution of engineering problems.

Range
List1 By examining experimental data using various origins **List 2** Including interpolate between known points **List 3** Extrapolate Graph Trends **List4** graphically calculation **List5** First order equations

List6
peak values
phase difference

List7
Pressure
Density
Relative density
Temperature

List8
ICAO tables
Take-off performance graphs
Fuel data

Learning outcome
The learner will: 6. understand the nature of matter
Assessment criteria
The learner can: 6.1 explain the kinetic theory of matter 6.2 identify common engineering chemical elements by name and symbol 6.3 explain the three basic states of matter and the changes of state of common substances 6.4 explain the three main bonds at molecular level 6.5 describe the nature of molecules found in metals and non-metals 6.6 explain the difference between heat and temperature 6.7 explain the relationship between the common temperature scales 6.8 convert temperature values between the common temperature scales 6.9 identify specific values using ISA tables.

Range
List1 Random motion of particles Brownian motion Gas properties of pressure, temperature and volume Conduction, Convection, Radiation, Adiabetic compression **List2** Carbon Iron Aluminium Copper **List3** Solid Liquid

Gas

state changes: solid > liquid > gas >liquid > gas
latent heat
features of state changes such as the expansion of water when frozen.

List4
Metallic
Ionic
Covalent
Relative strengths of each bond
Reasons for forming each type

List5
Materials used in aircraft
Steel
Aluminium alloys
Plastics
Conductors
Insulators

List6
Engineering explanation using aircraft related examples

List7
Kelvin
Degrees Fahrenheit
Degrees Celsius
Thermometers

List8
Kelvin
Degrees Fahrenheit
Degrees Celsius

List9
E.g.
Altitude
Temperature
Density.

Learning outcome
The learner will: 7. understand principles of statics
Assessment criteria
The learner can: 7.1 identify forces represented graphically as vectors 7.2 explain the concept of equilibrium 7.3 define the meaning of 'the moment of a force about a point'

7.4 define centre of gravity
7.5 solve problems involving straight levers, bell cranks and aircraft loading
7.6 use the 'triangle of forces' theorem to graphically solve problems
7.7 use the 'parallelogram of forces' theorem to graphically solve problems
7.8 define pressure and its units
7.9 explain the difference between gauge pressure and absolute pressure
7.10 solve problems involving atmospheric, gauge and absolute pressures
7.11 use basic physical measurement to calculate pressures in liquids.

Range

List1
Define 'vector'
Draw vector lines to represent forces in a system

List2
With respect to mechanical systems

List3
Basic principle of moments

List4
Explain the meaning
Examples of position in common objects including aircraft

List5
Bell crank on control cables
Aircraft balance about main undercarriage on the ground
Aircraft loading to adjust C of G

List6
Including some aircraft-related problems

List7
Including some aircraft-related problems

List8
The atmosphere
Free liquids and gases
Constrained liquids and gases
Gas laws (Boyle's, Charles)
Stress and strain in materials

List9
Aircraft-related examples

List10

Aircraft related

List11
Measuring height
Applying p = þ gh

Learning outcome
The learner will: 8. understand principles of linear, angular and oscillating motion related to aircraft in flight
Assessment criteria
The learner can: 8.1 define speed, velocity and acceleration 8.2 state Newton's Laws of Motion 8.3 explain the relationships F = ma and W = mg 8.4 define the equations of linear motion for constant acceleration 8.5 solve problems related to an aircraft in flight 8.6 define basic terms for angular motion 8.7 define terms for oscillating motion 8.8 explain simple harmonic motion in terms of mass-spring and simple pendulum systems 8.9 calculate the natural frequency of small oscillations in a pendulum.

Range
List1 Including acceleration due to gravity and its approximate value **List2** In standard form Include aircraft-related examples **List3** Including aircraft-related examples **List4** s= ut + ½ at2 v = u + at v2 = u2 + 2as **List5** Newton's Laws of Motion Linear motion equations **List6** Centripetal acceleration Centrifugal force Angular velocity Calculations

List7
For elastic systems:
Free vibration
Simple harmonic motion
Forced vibration
Resonance
Time period
Cycle
Frequency
Amplitude

List8
Applying definitions in (7.)

List9
pendulum formula for small oscillations.

Learning outcome
The learner will: 9. understand principles of dynamics related to aircraft in flight
Assessment criteria
The learner can: 9.1 define terms relating to simple machines 9.2 solve problems involving simple machines 9.3 explain terms related to gyroscopic motion 9.4 define work and power 9.5 define common forms of energy 9.6 explain the concept of the conservation of energy 9.7 solve simple problems involving potential and kinetic energy 9.8 explain terms related to friction 9.9 solve simple problems involving friction affecting objects on horizontal surfaces.

Range
List1 Velocity ratio Mechanical advantage Efficiency **List2** Related to aircraft where possible: Relationship between pressure, force and area Pulley systems Worm and wheel Levers Gears Screw jack

Efficiency

List3
Momentum
Inertia
Rigidity
Precession
Gimbal Lock, Degrees of freedom

List4
Calculations

List5
Potential
Kinetic
Heat
Electrical
Chemical

List 6
E.g. 'energy can neither be created nor destroyed, but only converted from one form to another'

List7
Related to aircraft where possible:

List8
Static friction
Dynamic friction
Coefficient of friction
Reaction
Normal force

List9
Applying definitions in 8

Learning outcome
The learner will: 10. understand principles of fluid motion related to aircraft in flight
Assessment criteria
The learner can: 10.1 explain density and relative density (specific gravity) 10.2 solve simple problems involving changing altitude 10.3 explain the meaning of viscosity 10.4 describe the effects of streamlining on the properties of air over an aerofoil surface 10.5 explain Bernoulli's Principle for non-viscous fluids 10.6 explain the relationship between Bernoulli's principle, a venturi and lift on an aerofoil.

Range
List1 fuel **List2** Changes with altitude of air properties: Density Pressure Temperature **List3** Resistance to fluid flow Shear stresses close to the system boundary **List4** Velocity of the air Resistance of the air **List5** potential energy kinetic energy pressure energy remain constant in the streamline. **List6** Simplified explanation.

Unit 001 Aviation mathematics and science for technicians

Supporting information

Guidance

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 1 – Mathematics and Module 2 – Physics, for Category A Licences but is taught to the depth for Category B1. B1 syllabus paragraphs not covered are:

- 1.2b – Logarithms (only)
- 2.3b – Thermodynamics
- 2.4 – Optics (Light)
- 2.5 – Wave Motion and Sound

The equivalent EASA knowledge level indicators for each of the above outcomes are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 2 (3.1-3) EASA Level 2 (3.4-7)
Outcome 4: EASA Level 2 (except 4.3 – EASA Level 1)
Outcome 5: EASA Level 2
Outcome 6: EASA Level 1 (except 6.6-8 – EASA Level 2)
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 2
Outcome 10: EASA Level 2

Note: the above list equates to the EASA requirement for category B licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 002 Civil manufacturing legislation in aviation

UAN:	T/503/1281
Level:	3
Credit value:	4
GLH:	30
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 001, 049.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner a working knowledge of aviation legislation as it applies to the manufacture of aircraft and aircraft parts.

Learning outcome
The learner will: 1. know the general framework of aviation legislation in the UK and Europe
Assessment criteria
The learner can: 1.1 describe the main parts of the civil aviation regulatory framework 1.2 describe the relationship between parts of airworthiness regulations 1.3 describe the legal requirements for commercial air transport

Range
List1 Overview of the role of the: International Civil Aviation Organisation (ICAO) European Aviation Safety Agency (EASA) Member States UK CAA **List2** Overview of: Part 21 - Aircraft Design and Manufacture Part 66 - Training and Certification Part 145 - Approved Maintenance Organisations Part 147 - Approved Training Organisations Part-M - Aircraft Maintenance

List3
E.g. overview relating to aircraft and parts manufacture:
Air Operators' Certificates
Operators' responsibilities
Documents to be carried
Aircraft Placarding (Markings)
Responsibilities of manufacturers and parts suppliers
Aircraft certification: general

Learning outcome
The learner will: 2. understand how civil aviation legislation relates to design and manufacture of aircraft and parts
Assessment criteria
The learner can: 2.1 explain the practical application of international civil aviation regulations 2.2 explain the practical application of national requirements for maintenance of airworthiness in civilian aircraft

Range
List1 Including: Aircraft Type Certificates – Part 21B Production Organisations Approvals (POA) – part 21G Airworthiness Certificates – part 25H Design Organisations Approvals (DOA) – part 21J Repairs – part 21M Identification of Products, Parts and Appliances – Part 21Q Acceptable Means of Compliance (AMC) **List2** Including: Inspection and control of materials used in manufacture Bonded stores Master Minimum Equipment Lists Airworthiness Directives Service Bulletins Manufacturers' Service Information Modifications and Repairs Maintenance Manuals Structural Repair Manuals Illustrated Parts Catalogues.

Learning outcome
The learner will: 3. be able to use procedures related to aviation legislation in manufacture
Assessment criteria
The learner can: 3.1 review certification documentation and determine its validity 3.2 perform typical procedures related to the supply and storage of aircraft equipment and spares 3.3 describe the authorisations and certifications required to manufacture typical critical aircraft components 3.4 perform the steps to fit typical critical aircraft components during manufacture

Range
List1 Including: Aircraft Type Certificate (authority, registration, date) Parts certificate/marking Material certificate/marking Tool calibration certificate **List2** Including authorisations to produce and supply Describe the route from raw materials to supplying the end-user **List3** Including all of the required authorisation, inspection and certification Components e.g. flying controls, undercarriage, pylons, primary structure Within a part 21J organisation

Unit 002 Civil manufacturing legislation in aviation

Supporting information

Guidance

This unit is designed to give the learner the knowledge required to establish the vital link between what they will be doing in the aircraft manufacturing environment and the operation of the aircraft they will be helping to build.

This unit is closely allied to the Human Factors unit in that it helps to establish the required attitudes towards the environment that the learner will be working and the tasks they will be required to perform. It should be delivered in such a way as to give a clear understanding of the legal requirements of the aviation industry and of the clear links between manufacturing and operations, whilst at the same time to engender a sense of responsibility that is essential at all levels.

The aim of learning outcome 1 is to introduce the learner to aviation legislation and to highlight the links between the requirements for design and manufacture, and those for aircraft operators.

Unit 003 Aerodynamics and control in fixed wing aircraft

UAN:	D/503/0965
Level:	3
Credit value:	5
GLH:	40
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 046, 059.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner a working knowledge of aircraft aerodynamics and control to as a basis for further study. It contains syllabi for the EASA 2042/2003 part 66 Basic Knowledge Requirements Module 8 and for part of Module 11A (11.1 only).

Learning outcome
The learner will: 1. know the basic properties of the Earth's atmosphere
Assessment criteria
The learner can: 1.1 describe the basic nature and composition of the Earth's atmosphere 1.2 describe the main layers of the Earth's atmosphere 1.3 solve problems using the basic gas laws 1.4 describe the use of the International Standard Atmosphere (ISA) in aviation

Range
List1 Air composition Temperature Pressure Density Position on the Earth's surface Climatic conditions **List2** Including the region of constant temperature (with altitude)

List3
Boyle's Law
Charles' Law
Gay-Lussac's Law
Combined Gas Law
Using primary control surfaces

List4
Quoting values at sea level in SI and Imperial units:
Pressure: psi, Nm-2, bar, millibar, hectopascal
Density: kgm-2
Temperature: °C, Kelvin, °F

Learning outcome
The learner will: 2. understand the nature of airflow around aerodynamic bodies
Assessment criteria
The learner can: 2.1 describe the main properties of airflow 2.2 describe how air flows around an aerodynamic body 2.3 explain how an aerofoil stalls 2.4 explain the effect of a stalled aerofoil on an aircraft in flight 2.5 describe the main characteristics of symmetrical and cambered aerofoils 2.6 describe how the airflow around aerofoils changes with angle of attack and velocity 2.7 explain how lift and drag affect aircraft performance 2.8 use standard equations to explain how lift and drag can vary 2.9 explain how a high lift device alters the flow characteristics of an aerofoil 2.10 explain how the total drag of an aircraft is generated 2.11 describe common methods of drag reduction

Range
List1 E.g. Compressible Viscosity Changed by temperature, solid objects etc. **List2** Related to different types of flow including: Laminar, turbulent (boundary layer) Free stream Up and down wash Vortices Features including: Stagnation point/region Transition and separation points

List3
Mechanism in terms of airflow
Critical angle of attack
Stalling angle

List4
Effect in terms of passage through the air and degree of control available
E.g. level stall, spin.

List5
Related to 2 and including:
Chord line
Mean camber line
Angle of attack
Angle of incidence
Fineness ratio
Thickness to chord ratio (percentage)

List6
With reference to Bernoulli's principle
Including resulting static pressure changes following:
Changes in angle of attack, including around the stall
Velocity changes
Types of drag

Effects including changes in:
Pressure distribution
Total air reaction
Lift
Drag

List7
Simple explanation

List8
Including, for both cambered and symmetrical aerofoils:
How the following change with angle of attack:
Lift coefficient
Drag coefficient
Lift/drag ratio

List9
E.g.
Airflow separation
Changes in lift and drag coefficients

List10
Including explanations of:
Induced drag

Pressure or form drag
Skin friction
Interference drag
Parasite drag

List11
E.g.
Polished surfaces
Fairings
Special materials
Aerodynamic shape

Learning outcome
The learner will: 3. understand the characteristics of the basic wing planforms
Assessment criteria
The learner can: 3.1 describe the basic wing planforms and their typical applications 3.2 apply simple dimensional calculations for each basic wing planform 3.3 describe the airflow over each basic wing planform 3.4 describe the effect of ice, snow and frost build-up on the performance of aerofoils

Range
List1 Rectangular Tapered Swept Delta **List2** Span Aspect ratio Taper ratio Gross wing area Wash in Wash out **List3** Using simple diagrams: In normal flight At or near the stall **List4** E.g. Change of shape Increase in weight Variation in thickness

Learning outcome
The learner will: 4. understand the principles of aircraft control
Assessment criteria
The learner can: 4.1 explain the relationship between the four main forces acting on an aircraft 4.2 explain the meaning of 'aircraft control' 4.3 describe the operation and effect of the primary aircraft control surfaces 4.4 explain the need for instinctive control 4.5 describe typical aircraft performance in different phases of flight 4.6 describe how turning flight is related to the stall 4.7 describe how turning flight changes the loading on an airframe

Range
List1 Lift Drag Thrust Weight Balancing effect of the tailplane **List2** Any accepted definition **List3** Elevator Aileron Rudder **List4** Define instinctive control Describe the relationship between: Control movements made by the pilot Control surface movement Movement of the aircraft **List5** Straight and level flight Climb Descent Glide Turn **List6** Aerodynamic explanation Spins

List7
Simple explanation including the effect on structural defects.

Learning outcome
The learner will: 5. understand the principles of aircraft stability
Assessment criteria
The learner can: 5.1 explain the nature of aircraft flight stability 5.2 relate the three aircraft axes to different types of stability 5.3 explain the differences between statically stable, unstable and neutral aircraft 5.4 describe major components on an aircraft that affect stability in flight 5.5 describe typical methods of enhancing stability

Range
List1 E.g. Active stability Passive stability **List2** Pitch stability e.g. Short period pitch oscillation Long period pitch oscillations (Phugoid) Lateral stability e.g. Dutch roll Directional stability e.g. Weathercocking **List3** Definitions and examples of: Static or positive stability Negative stability (unstable) Zero stability (neutral) **List4** E.g. Position and size of vertical stabiliser(s) Shape and mounting of the wings (e.g. anhedral/dihedral, aspect ratio etc.) Design of the tailplane **List5** E.g. Adjusting the centre of gravity

Design of lifting and control surfaces (e.g. wings, canards, tailplane etc.)

Learning outcome
The learner will: 6. understand the purpose and operation of secondary flying control surfaces
Assessment criteria
The learner can: 6.1 describe secondary effects of roll and yaw and methods of overcoming them 6.2 describe the arrangement and operation of alternative and combined flying controls 6.3 describe the general flow characteristics of high lift devices 6.4 compare the performance of trailing edge high-lift devices 6.5 describe the aerodynamic problems caused by asymmetric flap operation 6.6 compare the performance of leading edge high-lift devices 6.7 explain the purpose and operation of stall strips/wedges 6.8 describe methods of boundary layer control 6.9 compare the operation of high drag devices

Range
List1 Description in terms of airflow over control surfaces Main issue is adverse yaw Explain the effect of adverse yaw on roll rate Ways of counteracting averse yaw e.g. Differential ailerons Frise ailerons Roll spoilers Explain the secondary roll effect of applying rudder Explain this is worse in V-tailed aircraft Co-ordinated use of rudder and aileron **List2** Arrangement, operation and reasons for: Spoilers All-moving tailplane (slab/stabilator) Tailerons Canards Elevons Ruddervators Flaperons **List3** Using the example of e.g. a trailing edge flap Explanation to centre on: Airflow changes on deployment e.g. Change in lift and drag coefficients

Airflow separation

List4
Advantages, disadvantages with respect to aerodynamic effectiveness and operation:
Plain flap
Split flap
Slotted flap
Fowler flap

List5
Explanation of asymmetric flap and how it happens
Description of the effect on aircraft attitude

List6
Advantages, disadvantages with respect to aerodynamic effectiveness and operation:
Krueger flap
Leading edge droop
Slots
Slats

List7
Reason
Position
How they operate

List8
E.g.
Blown air
Suction
Wing fences

List9
Including limitations in flight and on the ground
Spoilers
Lift dumpers
Speed brakes

Learning outcome
The learner will: 7. understand methods of balancing and trimming control surfaces
Assessment criteria
The learner can: 7.1 explain the effects of airspeed on flying controls 7.2 explain the need for aerodynamic balancing 7.3 explain the operation of control surface trimming devices 7.4 describe control surface flutter 7.5 explain mass balance

Range
List1 E.g. Increased airspeed = greater force on controls E.g. Increased airspeed = smaller controlled movements required **List2** E.g. Counter-acting increased force from increased airspeed **List3** Include reasons for trimming devices Balance tab Anti-balance tab Spring tab Trim tab Servo tab Variable incidence tailplane **List4** Related to airspeed Effects of vibration on: Pilot Airframe Control linkage **List5** Why is it done and how is it achieved? Include explanations of: Out of balance force Forward and rear limits Centre of gravity

Learning outcome
The learner will: 8. understand the basic theory of high speed flight
Assessment criteria
The learner can: 8.1 explain the significance of 'speed of sound' to an aircraft in flight 8.2 explain terms related to high speed flight 8.3 explain 'Mach number' and 'critical Mach number' 8.4 describe the formation and development of shock waves 8.5 explain terms related to transonic flight 8.6 explain methods of overcoming problems during transonic flight 8.7 describe the factors affecting airflow through an intake of a high speed aircraft

Range
List1 Define ‘speed of sound’ Include variation of speed of sound with atmospheric conditions e.g. Altitude Air density Temperature **List2** Subsonic flight Transonic flight Supersonic flight **List3** Including their significance to aircraft flight **List4** Including: How and when they are formed How and why they develop Their properties Effect on the airflow e.g. Movement of the centre of pressure **List5** Compressibility Buffet Shockwave formation Spanwise flow Shock stall Boundary layer flow separation Control ineffectiveness Instability **List6** Swept wings Wing fences Saw-tooth leading edges Notched leading edges Vortex generators Area rule Spoilers Slab tailplane/stabilators Active stability devices **List7** Intakes e.g. Engine intakes

Air scoops Problems with high sped and supersonic air e.g. Shock wave Air too fast for engine intake Solutions e.g. Variable geometry intakes.

Unit 003 Aerodynamics and control in fixed wing aircraft

Supporting information

Guidance

It is expected that the learner will carry out suitable practical experiments to assist understanding of some aspects of this unit, however these will not be assessed.

This unit contains the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 8 and for part of Module 11A (11.1 only). The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 and B2 categories - are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 2
Outcome 4: EASA Level 2
Outcome 5: EASA Level 2
Outcome 6: EASA Level 2 (B1 only)
Outcome 7: EASA Level 2 (B1 only)
Outcome 8: EASA Level 2 (B1 only)

Note: the above list equates generally to the EASA requirement and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 004 Human factors in aviation

UAN:	M/503/1263
Level:	3
Credit value:	5
GLH:	40
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 2 NOS Units 001 and 003.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	The aim of this unit is to give the learner a comprehensive knowledge of human factors within the aircraft industry to assist them in living and working safely. It is a mandatory subject within the industry. The unit covers the complete syllabus of EASA Module 9 for Category B 1 and B2 licences.

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' 1.2 explain why Human Factors is important in the aeronautical engineering workplace 1.3 explain categories of Human Factor that are important to aeronautical engineering staff

Range
List1 Meaning of the term and how it is used in aviation 'Murphy's Law', SHEL Model, Anthropometry **List2** E.g. Safety of employees, passengers, people on the ground etc Safety of assets (e.g. aircraft, equipment etc) Long-term health of employees Efficiency of the organisation **List3**

E.g.
Working environment
Work patterns
Social habits
Work load
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 limitations of human memory 2.4 describe factors that affect mental attention span 2.5 describe how variations in an individual's sight and hearing can affect their behaviour 2.6 explain how working in challenging environments presents risks to airworthiness

Range
List1 To include: 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 **List2:** To include: Main parts of the ear Vulnerable parts of the ear Effect of noise – percussive, prolonged high intensity, varying pitch Noise Induced Hearing Loss (NIHL) Legal requirements for hearing protection Correct protection for frequency range **List3** Simple explanation e.g. Time from exposure to information Form that information is in (audio, visual, words, pictures etc.) Fatigue Age Complexity of information

Artificial stimulants/depressants
Types (iconic, echoic, episodic, symantic)

List4
E.g.
Overconfidence
Boredom
Fatigue
Complexity of information
Artificial stimulants/depressants

List5
Individually and i combination (such as in older people)
Sight e.g.
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
Long and short sight
Use of spectacles and magnifiers
Hearing e.g.
High and low tone deafness
Tinnitus
Hearing damage, poor communication
Social isolation (at work and at home)

List6
At height and in confined spaces e.g.
Claustrophobia
Fear of heights
Limited access/egress to a large space
Confined space
Specific tasks (e.g. 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 aircraft engineering environments 3.2 explain motivation and de-motivation 3.3 explain 'peer pressure' 3.4 explain company culture

3.5 explain the concepts of team working
3.6 identify the primary responsibilities of engineering managers and supervisors
3.7 discuss the basic concept of leadership

Range

List1

Outline of a typical organisation (must include 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 (e.g. rivalry, polarisation, 'social loafing')

List2

Overview of:
Fulfilling individual needs
Maslow's Hierarchy of Needs
Individual motivation
Motivation by management
Characteristics of motivation and de-motivation
How they can be affected by internal and external factors e.g.
Management decisions
Personal situation

List3

E.g.
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

List4

Overview of different types of culture (e.g. safety, organisational, shift, team, social etc.)
More detailed knowledge of safety culture and the individual
How company culture can compromise best working practices

List5

What is a team?
Advantages and disadvantages of team working
Team identity
Working with other teams
Ownership of tasks
Communication
Co-operation
Mutual support

List6

Difference between management and supervisor roles

What should an employee expect from a supervisor? (e.g. motivation, support, guidance etc.)

Engineering organisations (e.g.part145, military maintenance organisation)

List7

What is a leader?

The basic characteristics of a leader.

How and when any individual might provide leadership e.g.

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 effects of personal health and fitness on work performance 4.2 identify types of stress 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 4.7 explain the personal legal obligations of individuals in the aviation industry

Range
List1 Legal requirement for individual physical and mental fitness while at work Types of medical condition that might affect work e.g. Minor illness (e.g. cold, 'flu, sickness etc.) Major physical illness (e.g. heart attack, stroke, cancer etc.) Mental illness (e.g. depression etc.) Minor physical injury (e.g. sprained wrist, pulled muscle, cramp etc.) Major physical injury (e.g. broken bones, lacerations etc.) Effects of toxins and other substances (e.g. carbon monoxide, alcohol, drugs etc.) Gradual deterioration in physical condition **List2** Define 'stress' (e.g. eustress, distress, acute stress, chronic stress, hypo stress, hyper stress) Sources: Home (e.g. family illness, divorce etc.) Work (organisational, task related)

Types:
Acute and chronic stress
Signs of stress (physical, health, behaviour, cognitive, other)
Explain how stress can affect individual performance at work

List3
Actual, perceived and self-imposed deadlines
Effects of time pressure and deadlines
Managing time pressure and deadlines

List4
Definition of work overload and underload
Results of work overload and underload
Factors determining workload
Workload management

List5
What is sleep?
Five stages of sleep
Circadian rhythms
Fatigue (causes, symptoms)
Advantages and disadvantages of shift work
Working at night
Types of shift pattern

List6
Effects of alcohol
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

List7
E.g.
Alcohol limits and legal requirements for aircraft engineers
CAP 562 Leaflet 15-6/AN47
Transport legislation/AN45
Health and Safety legislation

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 effects of noise on individuals and groups
5.2 explain effects of fumes on individual performance
5.3 explain effects of varying illumination on an individual performance
5.4 explain effects of variations in climate on an individual performance
5.5 explain effects of exposure to constant motion and vibration while working
5.6 explain effects of layout of a working environment on individual performance

Range

List1
E.g. effects on:
Concentration
Communication

List2
E.g. effects on:
Concentration
Communication
Longer term effects
Safe oxygen levels

List3
E.g.
Ability to see detail
Moving between areas of different illumination, including well-lit hangar and night flight line
Strobe effect and propellers

List4
E.g.
Cold/wet, warm/dry, hot/humid environments

List5
E.g.
Working at height on scissor platforms and cherry picker
Unsteady platforms
Use of rotating or percussive tools
Vibration White Finger (VWF)

List6
E.g.
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 effects of physically demanding work on individual performance 6.3 explain effects of repetitive tasks on individual performance 6.4 explain aspects of visual inspection 6.5 explain aspects of working on complex systems

Range
List1 E.g. Defining the task Defining the resources Personal skills and proficiency Information **List2** E.g. Health and physical condition, effects of ageing Work environment Physical effort Effects of ageing **List3** E.g. Ignoring manuals, job cards etc. Complacency Making assumptions **List4** E.g. Importance of good eyesight Knowledge of the inspection area Illumination Concentration Systematic search **List5** E.g. 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 maintaining individual professional currency 7.5 explain the importance of information dissemination

Range
List1 Within and between groups e.g. Prevention of accidents Maintaining good working relations Organisational efficiency **List2** E.g. Formal work logging Shift logging Shift handover Task staging Duplicate Inspection Stage sheets/check **List3** E.g. Verbal Written Body language Workplace social culture Communication between all levels of an organisation **List4** E.g. 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: 8. understand the causes of human error
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
List1 E.g. Induced Variable Reversible/irreversible Slips, lapses and mistakes The 'Swiss Cheese Model' **List2** E.g. Complacency Environmental capture Rule-based errors Violations Individual practices and habits Errors associated with visual inspection Latent/Active errors **List3** E.g. Self discipline Safety Management System Anonymous and blame-free reporting Training Logging and analysis.

Learning outcome
The learner will: 9. understand the human factors aspects of aircraft incidents
Assessment criteria
The learner can: 9.1 analyse an incident report to extract information 9.2 identify a sequence of events from a narrative report 9.3 identify human factors contributing to an incident 9.4 draw conclusions from incident data

Range
List1 Using extracts from an actual report or a realistic example Filter out irrelevant detail **List2** How, why, when where, who Use presentation aids such as flow diagrams Identify what should have been done **List3** Analyse the information and identify contributing factors Including where possible: Personal behaviour Environmental conditions Management Organisational culture Using e.g. MEDA MEMS **List4** Including where necessary, brief details of: Environment Personal issues Organisation Nature and mix of allocated tasks Recommendations for preventative action

Learning outcome
The learner will: 10. understand risk assessments in aeronautical engineering environments
Assessment criteria
The learner can: 10.1 define the terms associated with risk assessment 10.2 describe the five steps to risk assessment 10.3 describe the associated risks for workplace hazards 10.4 describe conclusions from risk assessments 10.5 explain how to manage workplace emergencies

Range
List1 Hazard Risk Severity Likelihood (probability)

List2

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

List3

Step 2

List4

Steps 2&3

Recommend ways of eliminating or reducing to an acceptable level, a range of identified risks

List5

Steps 3&4 e.g.

Reduce the likelihood of them happening

Management of workplace emergency situations such as fire, spillage, personal injury etc.

Unit 004 Human factors in aviation

Supporting information

Guidance

The teaching of the knowledge content of this unit should be referenced to the Civil Aviation Authority (CAA) publication CAP715 or its military equivalents. The City & Guilds GOLA examination is based on the content of CAP 715.

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 9 – Human Factors. The equivalent EASA knowledge level indicators for each of the above outcomes are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 1
Outcome 4: EASA Level 2
Outcome 5: EASA Level 1
Outcome 6: EASA Level 1
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 2
Outcome 10: EASA Level 2

Note: the above list equates to the EASA requirement for category B licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 005 Aircraft manufacture

UAN:	L/503/1271
Level:	3
Credit value:	9
GLH:	70
Relationship to NOS:	This unit is linked to the Level 3 Aeronautical Engineering NOS Units 005-011, 039.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit provides the learner with a detailed knowledge of aircraft manufacturing processes used for metal airframes and components. It also gives the learner some practical experience in using some of the more basic techniques.

Learning outcome
The learner will: 1. know the machining processes used in the production of aircraft components
Assessment criteria
The learner can: 1.1 describe the process of turning 1.2 describe the process of milling 1.3 describe the process of grinding 1.4 describe the process of routing 1.5 describe the safety precautions required for machining processes

Range
List1 Typical machines and equipment Cutting tools and material Cutting action Typical allowances and tolerances Typical components produced Changes in material properties **List2** Typical machines and equipment Cutting tools and material Cutting action

Typical allowances and tolerances
Typical components produced
Changes in material properties

List3
Typical machines and equipment
Cutting tools and material
Cutting action
Typical allowances and tolerances
Typical components produced
Changes in material properties

List4
Typical machines and equipment
Cutting tools and material
Cutting action
Typical allowances and tolerances
Typical components produced
Changes in material properties

List5
Hazards
Precautions e.g.
PPE
Machine guards
Pre-use checks
Emergency cut-off.

Learning outcome
The learner will: 2. know the casting processes used in the production of aircraft components
Assessment criteria
The learner can: 2.1 describe the process of sand casting 2.2 describe the process of die casting 2.3 describe the process of investment casting 2.4 describe changes to properties of metals brought about by different casting methods 2.5 describe the safety precautions required for metal casting processes

Range
List1 E.g. Typical equipment Materials (types of sand, pattern, metals) General process: Pattern making

Mould forming
Pouring
Cooling
Separation
Finishing
Inspection
Typical faults
Typical allowances and tolerances
Typical components produced

List2
E.g.
Typical equipment, dies, general types of machine etc.
Metals used
General process:
Molten metal
Injection
Cooling
Component removal
Finishing
Inspection
Typical faults
Typical allowances and tolerances
Typical components produced

List3
E.g.
Typical equipment
Materials (types of sand, pattern, metals)
General process:
Pattern making
Mould forming
Pouring
Cooling
Separation
Finishing
Inspection
Typical faults
Typical allowances and tolerances
Typical components produced

List4
For ferrous and non-ferrous alloys used in aircraft manufacture:
Changes to:
Hardness
Toughness
Ductility
Tensile strength
Grain structure
Due to e.g.

Mould materials
Cooling rates
Finishing methods

List5
Hazards
Precautions e.g.
Safety equipment (PPE, fire extinguishers etc.)
Environment
Equipment pre-use checks
Safe practice

Learning outcome
The learner will: 3. understand the metal forming processes used in the production of aircraft components
Assessment criteria
The learner can: 3.1 describe the general process of hot forming used on typical metals used in aircraft 3.2 describe the general process of cold forming used on typical metals used in aircraft 3.3 describe changes to properties of metals brought about by different forming methods 3.4 describe safety precautions required for the hot and cold forming processes

Range

List1
Rolling
Extruding
Drawing
Forging
Finishing methods
Inspection
Typical faults
Typical allowances and tolerances
Typical components produced

List2
Bending
Cold working
Work hardening
Pressing
Finishing
Inspection
Typical faults
Typical allowances and tolerances
Typical components produced

List3
For ferrous and non-ferrous alloys used in aircraft manufacture:
Changes to:
Hardness
Toughness
Ductility
Tensile strength
Grain structure
Due to e.g.
Temperature
Cooling rate
Quenching medium
Feed speed

List4
Hazards
Precautions e.g.
Safety equipment (PPE, fire extinguishers etc.)
Environment
Equipment pre-use checks
Safe practice

Learning outcome
The learner will: 4. understand the metal heat treatment processes used in the production of aircraft components
Assessment criteria
The learner can: 4.1 describe the common heat treatments applied to aircraft grade steels 4.2 describe the common heat treatments applied to aircraft grade aluminium alloys 4.3 describe the safety precautions required when heat treating metals

Range
List1 Process of: Annealing Normalising Hardening Tempering Changes in: Hardness Toughness Ductility Tensile strength Grain structure Effects of changing e.g.

Temperature
Cooling rate
Quenching medium
Typical components requiring this treatment

List2
Process of:
Annealing
Solution treatment
Precipitation
Changes in:
Hardness
Toughness
Ductility
Tensile strength
Grain structure
Effects of changing e.g.
Temperature
Cooling rate
Quenching medium
Typical components requiring this treatment

List3
Hazards
Precautions e.g.
Safety equipment (PPE, fire extinguishers etc.)
Environment
Equipment pre-use checks
Safe practice.

Learning outcome
The learner will: 5. know the composite material manufacturing processes used to produce aircraft components
Assessment criteria
The learner can: 5.1 define common terminology used in composites manufacture 5.2 distinguish between the composite materials used in aircraft 5.3 describe typical methods of manufacturing aircraft parts from each material type

Range
List1 Definition of 'composite' E.g. fibre, matrix, fabric, lamina, honeycomb, autoclave **List2** Three main categories: monolithic, laminate, sandwich

Examples of each type e.g.
Moulded plastic part (monolithic)
Carbon fibre structure (laminate)
Floor board (sandwich)
Describe different fibres and why they are used: carbon, glass, aramid, quartz
Describe matrices and why they are used (e.g. epoxy and phenolic resins)
Describe typical plastics and why they are used (e.g. ABS, polycarbonate, acrylic)
Describe components of sandwich material e.g. nomex, aluminium honeycomb, adhesives

List3
Plastics (e.g. injection moulding)
Laminates (e.g. lay-up techniques)
Sandwich (e.g. hot and cold bonding techniques).

Learning outcome
The learner will: 6. understand the methods of producing holes in metallic materials used in aircraft manufacture
Assessment criteria
The learner can: 6.1 describe methods of drilling holes in aircraft structure 6.2 describe methods of reaming holes in aircraft structure 6.3 describe the use of positioning aids to assist in producing holes 6.4 describe the process of automatic and semi-automatic hole preparation 6.5 describe methods of finishing holes 6.6 describe the use of a range of drilling equipment 6.7 describe changes to material properties caused by drilling 6.8 identify hole production techniques for selected tasks 6.9 describe safety precautions required when drilling holes in aircraft structure

Range
List1 Datum holes Back-drilling Angle drilling Pilot drilling Drill reaming Final drilling Fits and tolerances Types of drill for common materials Drill speeds and feeds **List2** Parallel

Taper
Fits and tolerances

List3
Jigs
Fixtures
Templates
Laser measuring and positioning

List4
E.g. CNC

List5
Including:
Countersinking
Counter boring
Spot facing

List6
Pneumatic drills
Semi-automatic drills
Rack-feed
Automatic drilling
Boring tapered holes

List7
Changes at hole edges e.g.
Internal stresses
Surface damage
Corrosion risk

List8
E.g.
Material removal for repair, precision holes for fasteners etc.

List9
Hazards
Precautions e.g.
PPE
Safety guards
Work-piece protection

Learning outcome
The learner will: 7. know the assembly, fastening and sealing techniques used in aircraft manufacture
Assessment criteria
The learner can:

7.1 describe a range of assembly techniques for aircraft components 7.2 describe welding and soldering techniques used in aircraft component manufacture

Range
List1 Mechanical and electrical e.g. Manual (hand, tools, manually operated machine) Automatic (NC) Sealing and jointing Materials e.g. Adhesives Sealants Jointing compounds Fasteners Hazards and safety precautions Checks and inspection techniques Environmental conditions (temperature, humidity etc) Typical items which require each of the above **List2** General principles of welding Aircraft materials that are normally welded (e.g. steel, titanium) Processes: Gas MIG TIG Electrodes and fluxes Surface preparation and cleanliness Certification of aircraft welders Inspection of welds on aircraft Hazards and safety precautions Typical components requiring welded assembly or repair General principles of soldering Aircraft materials that are generally soldered (e.g. copper, brass) Soldering materials Soldering techniques Inspection of soldered joints Typical components requiring soldered assembly or repair

Learning outcome
The learner will: 8. know the completion and inspection procedures used in aircraft production
Assessment criteria
The learner can: 8.1 describe typical standards for completion and checking of airframe components and structures 8.2 describe the hazards and safety precautions associated with aircraft

inspection

8.3 describe typical techniques for inspecting airframe components and structures

8.4 describe typical methods of finishing airframe components and structures

8.5 describe typical pressure, functional and operational checks for airframe components and structures

Range

List1
E.g.
Company standards
CAA standards
MOD standards
Typical action on discovery of non-conformity

List2
E.g.
Working at height

List3
Including checks for:
Rigging
Symmetry
Locking
Bonding
Surface finish
Fasteners
Seals

List4
E.g.
Anti-electrolysis
Anodic
Chromate
Primer
Paints
Metallic coatings

List5
E.g. checks on:
Cabin pressure
Flying controls
Hydraulic systems
Fuel systems
Pneumatic systems
Electrical systems
Including:
Procedures

Equipment
Typical tolerances
Typical rectification if deviating from the standards e.g.
Re-rigging
Adjustment of micro switches
Replacement of pipes
Replacement of seals

Learning outcome
The learner will: 9. be able to use aircraft manufacturing processes
Assessment criteria
The learner can: 9.1 interpret technical instructions and information 9.2 plan tasks to meet inspection and finishing requirements 9.3 use metal forming processes used in the production of aircraft components 9.4 carry out a typical heat treatment process to an aircraft component. 9.5 use methods of producing holes in metallic materials used in aircraft manufacture 9.6 use assembly, fastening and sealing techniques used in aircraft manufacture 9.7 apply finishes to completed aircraft component assemblies 9.8 inspect completed aircraft component assemblies

Range

List1
Engineering drawings
Assembly procedures
Technical data
Inspection procedures
Checking procedures
Finish requirements

List2
To meet requirements e.g.
Selecting the appropriate checking, inspection and finish required
Identifying and obtaining the correct tools and equipment
Identifying and obtaining the correct materials
Determining the correct sequence of operations
Identifying safety precautions

List 3
E.g.
Bending
Manual cold working
Rolling

List 4

E.g.
Annealing
Hardening
Tempering

List5
E.g.
Drilling
Reaming
Countersinking
Counter boring
Thread production

List 6
E.g.
Jigs and fixtures
Fasteners e.g.
Nuts, bolts and studs
Rivets
Washers and locking devices
Sealants

List 7
For small areas:
Health and Safety
Surface preparation
Preparation and application of surface finishes

List 8
Ensure compliance with relevant engineering standards
Inspection using e.g.
Measuring equipment
Surface gauges
Profile gauges
Optical equipment

Unit 005 Aircraft manufacture

Supporting information

Guidance

This unit is intended to give a broad appreciation of the methods and techniques used in traditional aircraft manufacture and repair. The practical activities are intended to develop basic hand skills learned elsewhere into particular skills that can be used on aircraft. Practical tasks should be 'complex' as befits a Level 3 unit and assessment criteria should, where possible, be combined in a common aircraft-related task.

Unit 006 Fundamentals of electronics and avionics

UAN:	A/502/0956
Level:	3
Credit value:	10
GLH:	75
Relationship to NOS:	This unit is linked to the Aeronautical Engineering NOS – Units 076-085.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner sufficient knowledge of aircraft electrical and avionic principles to allow further study on specific systems.

Learning outcome
The learner will: 1. understand the principles of electrical current and charge
Assessment criteria
The learner can: 1.1 describe the structure of the atom 1.2 describe the distribution of electrical charge in different types of particle 1.3 describe the molecular structure of electrical materials 1.4 explain the principle of attraction and repulsion of charged particles 1.5 explain electrical conduction in different media 1.6 describe the nature of static electricity 1.7 describe safety precautions associated with static electricity 1.8 define terms associated with electricity 1.9 Illustrate the relationship between voltage, current, resistance and power

Range
List1 To a depth which allows understanding of: Electrical current Static electricity Molecules Compounds

List2
Atom
Molecule
Compound
Elements

List3
To a depth which allows understanding of:
Electrical current
Operation of semi-conductors
Electrical resistance
Conductors
insulators
Free electrons

List4
Simple explanation
Including Coulomb's Law

List5
Solid, liquid, gas, vacuum

List6
E.g.
Mechanism of formation of static electricity (friction then separation of different materials)
Types of materials
Environmental conditions
Generation of high discharge voltages
Potential to damage semiconductors etc
Practical examples

List7
With practical, aircraft-related examples e.g.
Refuelling
Conductive tyres
Workshop practice
Lox plants

List8
Including SI and Imperial (where appropriate) units for each:
Coulomb
Charge
Current
Resistance
Conductance
Electron flow
Conventional current flow
Potential difference
Electromotive force

Voltage
Electrical power

List9
Practically and theoretically:
Ohms Law
Kirchhoff's Current and Voltage Laws
Series and parallel
Solve practical problems

Learning outcome
The learner will: 2. understand the principles of aircraft electrical power generation
Assessment criteria
The learner can: 2.1 describe how electricity can be produced using a range of methods 2.2 explain how to calculate the internal resistance of a battery 2.3 describe the features of a sinusoidal waveform 2.4 explain terms relating to a sinusoidal waveform 2.5 describe the features of other common wave forms 2.6 make calculations relating to alternating current, voltage and power 2.7 describe a range of sensors

Range

List1
Including:
Light (photoelectric cells)
Heat Thermocouples)
Pressure (piezoelectric)
Chemical action (battery)
Magnetism and motion (generators)

List2
Standard calculation
Include the effects of internal resistance on an electrical circuit

List3
Including definitions of:
Phase
Frequency
Cycle

List4
Sinusoidal values:
Instantaneous
Average
Root mean square
Peak

Peak-to-peak

Lis5
Triangular (saw-tooth)
Square

List6
Calculations for:
Instantaneous
Average
Root mean square
Peak
Peak-to-peak

List7
The construction, operation and typical aircraft applications of e.g.
Piezoelectric crystal
Thermocouple
Photoelectric cell/Light Dependent Resistor (LDR)
“Firewire”

Learning outcome
The learner will: 3. understand the principles and uses of aircraft batteries
Assessment criteria
The learner can: 3.1 explain the chemical action of electrical cells 3.2 describe aircraft batteries 3.3 explain how the state of charge of aircraft batteries can be determined 3.4 describe the mandatory safety precautions for the servicing of aircraft batteries 3.5 describe maintenance procedures for aircraft batteries 3.6 explain how aircraft batteries are capacity-tested 3.7 explain constant voltage and constant current charging of aircraft batteries 3.8 explain ‘thermal runaway’

Range
List1 Basic principles Qualitative explanation of action Primary and secondary cells Standard cell voltages **List2** Purpose Minimum permissible capacity Construction and operation of typical:

Dry battery
Lead-acid battery
Nickel-cadmium battery
Other alkaline cells

List3
Using standard procedures

List4
Including during:
Charging
Testing
Transportation
Installation
Removal

List5
Lead-acid
Nickel-cadmium

List6
Explaining how and why, including:
Definition of capacity
Why capacity reduces
Consequences of un-noticed reduction in capacity

List7
Define constant current
Basic explanation of constant current charging
How and why it is done

List8
Including:
How thermal runaway happens
Consequences of thermal runaway
How to avoid thermal runaway

Learning outcome
The learner will: 4. understand the use of aircraft cables and associated devices
Assessment criteria
The learner can: 4.1 describe aircraft cables 4.2 explain the effect on performance of individual cables when placed in a loom or conduit 4.3 describe connector types used in aircraft 4.4 describe crimping tools used in aircraft applications 4.5 demonstrate the use of wire selection charts 4.6 describe installation procedures for aircraft cable looms

4.7 describe the process of soft soldering
4.8 describe the function and use of general aircraft test equipment
4.9 describe techniques for testing aircraft cables
4.10 explain aircraft electrical safety devices

Range

List1
Define EWIS (Electrical Wiring Interconnection System)
EWIS installations
The construction and purpose of typical cables e.g.
High tension
Co-axial
'Kapton' (explain special safety issues)
Special-purpose
General purpose
Fibre optic

List2
E.g.
Reduced current-carrying
Possible signal interference

List3
E.g. connectors used for:
High tension
Power
Data
Communications
Fibre-optics
Co-axial (BNC, TNC)

List4
Full range of aircraft-use tools for, including:
Ring tongue terminals (PIDG)
Splices
Miniature connectors
Explain:
Construction and operation
Calibration and pre-use checks
Consequences of using an incorrectly calibrated crimp tool

List5
Explain why and how they are used
Demonstrate using standard industry tables

List6
E.g.
Safety precautions
Routing

Securing
Protection
Cooling
Screening
Individual cables
Looms
Connectors and connector pins

List7
When and how it would be used including:
Flux
Solder composition
Heat sources
Cleanliness
Application
Joint inspection

List8
Electrical and avionic general test equipment including:
Ammeter
Voltmeter
Multimeter (analogue and digital)
Basic oscilloscope

List9
Including:
Automatic test equipment
Multimeter
Continuity tester
Insulation tester
Time Domain Reflectometer (TDR)

List10
The function and use of devices such as:
Relays
Circuit breaker
Fuses
Differential current detection

Learning outcome
The learner will: 5. understand aircraft cabling tasks
Assessment criteria
The learner can: 5.1 explain the use of crimping tools to terminate cables 5.2 explain construction processes for aircraft cable looms 5.3 describe how aircraft cables are identified using the ATA 100 system

Range
List1 Use of a range of terminations and crimp tools e.g. Ring tongue terminals Splices Miniature connectors Standard connectors Testing crimp joints **List2** General principles and methods using representative aircraft cable and components including: Different sizes of cable Different types of cable Signal and power Different types of loom tie Inspection Repair and maintenance Standards of cleanliness **List3** Marking systems e.g. ATA100 Marking materials e.g. Ink Sleeves Stamping For a range of cables e.g. Screened Co-axial High tension.

Learning outcome
The learner will: 6. understand aircraft power supplies
Assessment criteria
The learner can: 6.1 describe aircraft battery systems 6.2 describe the layout of a generic multi-engine electrical power distribution system 6.3 describe components of an aircraft electrical power distribution system 6.4 describe the main categories of aircraft electrical-powered services 6.5 explain how aircraft electrical power is maintained in the event of emergencies 6.6 explain the sequence of connection and disconnection of aircraft ground/external electrical power 6.7 describe the standard dc and ac ground power connectors

Range
List1 Block diagram Including the purpose of each component **List2** Block diagram Including the purpose of each component **List3** Generator Constant speed drive unit Main battery Emergency battery Rotary and static inverters Transformer rectifier units Generator control unit Bus tie relay/breaker Generator control relay Battery isolation switch RCCB (Reverse Current Circuit Breaker) **List4** Vital services Essential services Non-essential services **List5** Using: Standby generators Duplication of systems Batteries Emergency batteries Ram air turbines Transformer rectifier units Static inverters Auxiliary power unit **List6** Engine(s) running, pre/post taxi DC battery trolley Ground maintenance Petrol/diesel power set Electric/electric power set **List7** DC and AC connectors Position and purpose of each pin

Interlocking relays

Learning outcome
The learner will: 7. understand aircraft flight instruments and lighting systems
Assessment criteria
The learner can: 7.1 explain the operation of pitot-static instruments 7.2 explain gyroscopic motion 7.3 explain the operation of gyroscopic flight instruments 7.4 compare the operation of direct and remote reading compasses 7.5 describe the layout and operation of aircraft stall warning systems 7.6 describe the layout and operation of the three main aircraft lighting systems

Range
List1 Altimeter Airspeed indicator Vertical speed indicator Mach meter **List2** Qualitative explanation Define related terms including: Degrees of freedom Rigidity Precession Gimballing Topple **List3** Principles and purpose of: Artificial horizon Attitude indicator Direction indicator Turn and slip indicator **List4** Function, purpose and components of e.g. Emergency magnetic compass Detector unit Compass computer Compass indicator **List5** Typical arrangement and operation of e.g. Sensors

Warning devices

List6
External: navigation, landing, taxiing, ice
Internal: cabin, cockpit, cargo
Emergency

Learning outcome
The learner will: 8. understand digital aircraft control and monitoring systems
Assessment criteria
The learner can: 8.1 explain types of electrical signal 8.2 explain computer terminology 8.3 explain the purpose of a range of aircraft computer hardware 8.4 describe the main features of aircraft auto-flight control systems 8.5 explain radio signals 8.6 describe aircraft communication systems 8.7 describe the airborne navigation aids 8.8 explain the term 'databus' 8.9 describe aircraft electronic instrument systems 8.10 describe safety precautions when working on aircraft avionic equipment 8.11 describe aircraft onboard maintenance systems

Range
List1 Analogue and digital Simple explanation using sketched wave-forms **List2** Commonly used terminology e.g. Bit Byte Software Hardware CPU Chip Memory: RAM ROM PROM Hard Drive **List3** Input devices Output devices Microprocessor and interface devices

Visual display
Storage devices

List4
E.g.
The inherent instability of aircraft
The need for automatic stabilisation
Axes of control
Sensing devices (e.g. rate gyros)
Basics of negative and positive feedback and their effect on a control system
Full automatic control including heading and height
Inputs from other systems and ability to program in way-points etc

List5
Simple explanation of what they are and how they are propagated:
Nature e.g.
Electromagnetic waves
Basic frequency bands and their uses
Modulation types (frequency and amplitude)
Propagation e.g.
Ionosphere
Sky wave
Space wave
Ground wave
Typical ranges
Typical shapes of aircraft antennae

List6
Typical layout and operation of:
VHF
UHF
HF
Intercom
Satcom

List7
Basic function, inputs and outputs of:
VHF Omni-directional Ranging (VOR)
Instrument Landing System (ILS)
Automatic Direction Finder (ADF)
Distance Measuring Equipment (DME)
Global Positioning System (GPS)
Identification Friend or Foe/Secondary Surveillance Radar (IFF/SSR)
Traffic Alert and Collision Avoidance System (TCAS)
Weather Radar
Radio Altimeter
RNAV/FMS

List8

Simple explanation including aircraft applications
Overview of databus types and designations

List9
Layout and operation of a typical system e.g.
Electronic Flight Instrument System (EFIS)
Engine Indicating and Crew Alerting System (EICAS)
Electronic Centralised Aircraft Monitoring (ECAM)
Automatic Flight Control System (AFCS)

List10
E.g.
ESD protection
Manual handling
Power management
Working at height

List11
Typical layout, components and information outputs for a maintenance system e.g.
Built in test equipment (BITE)
Simple explanation of main monitoring areas and information output
Standard for on-board maintenance system is ARINC 624

Unit 007 Mechanical systems in aircraft

UAN:	H/503/1289
Level:	3
Credit value:	12
GLH:	90
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS 12, 15, 41-46, 49-59, 305, 309-314, 316, 319-322, 325.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner some practical skills and a detailed knowledge of aircraft mechanical systems in a manufacturing context to support practical skills to be further developed in the workplace.

Learning outcome
The learner will: 1. understand aircraft air and oxygen systems
Assessment criteria
The learner can: 1.1 explain aircraft air conditioning systems 1.2 explain aircraft cabin pressurisation systems 1.3 explain aircraft oxygen systems 1.4 explain aircraft pneumatic/vacuum systems

Range
List1 Typical function and layout e.g. Sources of supply including engine bleed, APU and ground cart Air conditioning system Air cycle and vapour cycle machines Distribution systems Flow, temperature and humidity control system Protection and warning devices **List2** Typical function and layout e.g. Pressurisation systems Control and indication including control and safety valves

Cabin pressure controllers
Protection and warning devices

List3
Typical function and layout e.g.
Cockpit, cabin
Sources
Storage
Charging
On-board generation
Distribution
Supply regulation
Indications and warnings
Interfaces with other systems (e.g. emergency)

List4
Typical function and layout e.g.
Sources: engine/APU, compressors, reservoirs, ground supply
Pressure control
Distribution
Indications and warnings
Interfaces with other systems

Learning outcome
The learner will: 2. understand aircraft fuel, hydraulic and water systems
Assessment criteria
The learner can: 2.1 explain aircraft fuel systems 2.2 explain aircraft hydraulic systems 2.3 explain aircraft water and waste systems

Range

List1
Typical function and layout e.g.
Fuel tanks
Supply systems
Dumping, venting and draining
Cross-feed and transfer
Indications and warnings
Refuelling ad defueling
Longitudinal balance fuel systems

List2
Typical function and layout e.g.
Hydraulic fluids
Hydraulic reservoirs and accumulators
Pressure generation: electrical, mechanical and pneumatic

Emergency pressure generation
Pressure control
Power distribution
Indication and warning systems
Interfaces with other systems

List3
Water system:
Layout
Supply
Distribution
Servicing
Draining
Waste system:
Layout
Flushing
Storage
Servicing
Additional water and waste issues e.g.
Corrosion
Contamination
Hygiene

Learning outcome
The learner will: 3. understand aircraft flight control systems
Assessment criteria
The learner can: 3.1 explain aircraft primary flying controls 3.2 explain aircraft secondary flying controls 3.3 explain methods of moving aircraft flying controls 3.4 explain additional flying control systems 3.5 explain adjustments made to flying controls on installation and replacement

Range
List1 Typical function and layout e.g. Aileron Rudder Elevator Attachment to airframe Use of gust locks **List2** Typical function and layout e.g. Spoilers Lift dump

Speed brakes
Flaps
Slats
Attachment to airframe
Actuation e.g. screw jack, hydraulic ram

List3
Typical function and layout e.g.
Manual
Hydraulic
Pneumatic
Electrical
Fly-by wire/light
Position and rate selection and feedback

List4
Typical function and layout including:
Artificial feel
Yaw damper
Mach trim
Rudder limiter

List5
Rigging
Balancing

Learning outcome
The learner will: 4. understand aircraft protection systems
Assessment criteria
The learner can: 4.1 explain aircraft fire protection systems 4.2 explain aircraft ice and rain protection systems 4.3 explain aircraft stall protection systems

Range
List1 Typical function and layout of: Fire and smoke detection e.g. Cabin Cargo hold Engines Equipment bays Fuel tanks Fire and smoke warning: Visual Audible Fire extinguishing system:

Manual (eg hand-held extinguishers)
Remote selected
Automatic
Extinguishing media e.g. foam, inert gas, water etc
System testing

List2
Ice formation, classification and detection
Typical function and layout of:
Anti-icing systems:
Electrical
Hot air
Chemical
De-icing systems:
Electrical
Pneumatic
Chemical
Rain repellent and removal
Probe and drain heating

List3
Typical function and layout including:
Sensing
Crew alert (klaxon, stick and pedal shaker)
Automatic recovery

Learning outcome
The learner will: 5. understand aircraft undercarriage systems
Assessment criteria
The learner can: 5.1 describe aircraft landing gear systems 5.2 explain the operational requirements of retractable landing gear 5.3 describe power sources for landing gear retraction and extension 5.4 explain the operation of hydraulically operated retractable landing gear systems 5.5 describe methods of lowering a retractable undercarriage in an emergency 5.6 describe procedures for carrying out an undercarriage retraction test 5.7 describe aircraft landing gear shock absorbers 5.8 describe maintenance operations for aircraft landing gear shock absorbers

Range
List1 Wheeled: Nose wheel Tail wheel

Bicycle

Explain layout and purpose of each type:
Single
Double
Bogie
Articulated
Other gear types:
Skids
Skis
Floats

Components and construction:
Shock absorber
Wheel
Brake unit
Steering system
Torque link
Axle
Retraction gear
Locking mechanism
Doors

List2
E.g. it must:
Retract and extend on demand in an acceptable time
Not interfere with the aircraft's aerodynamics when retracted
Lock in up and down positions
Not have adverse effects on aircraft handling when extended
Give indications when locked up and down and when travelling
Support the full weight of the aircraft on landing when locked down
Allow the aircraft to be steered whilst on the ground
Allow the aircraft to accelerate, decelerate and come to a stop on the ground
Allow the aircraft to be towed

List3
Purpose and function:
Electrical
Hydraulic
Pneumatic
Mechanical up and down lock
Side stays
Drag struts
Position indicator
Throttle warning switch
Selector baulk
Weight on wheels switch
Ground locks

List4
Sequence with doors and bogie tilting operation
Micro and proximity switches
Cockpit indications
Mechanical indicators
Up and down locking
Non-return valve
Selector
Mechanical sequence valve
Actuators
Restrictor valve
Shuttle valve
Fluid jettison valve

List5
E.g.
Free fall
Nitrogen blow-down
Electrical actuation
Emergency hydraulic accumulators

List6
Using external power
Safety precautions
Preparation of the aircraft (jacking, power etc)
Test procedure

List7
Construction, installation and operation of:
Oleo-pneumatic with separator
Oleo-pneumatic without separator

List8
Inspections:
Leakage
Corrosion damage
Correct gas charge
Use of load extension graphs
Installation:
Attachment points
Securing devices
Locking devices
Electrical, hydraulic and pneumatic connections
Adjustments
Maintenance operations:
Oil filling
Nitrogen charging

Learning outcome
The learner will: 6. understand aircraft nose wheel steering systems
Assessment criteria
The learner can: 6.1 describe nose wheel steering systems 6.2 explain methods of reducing or eliminating nose wheel shimmy 6.3 describe inspection and test requirements for aircraft nose wheel steering systems 6.4 describe installation and adjustment operations on aircraft nose wheel steering systems

Range
List1 Reasons for its use e.g. No rudder control below certain speeds Directional control during taxi, takeoff and landing Performance requirements Describe the parts and layout: Control valve Non-return valve Dual pressure relief valve Double acting actuator Feedback system Explain the reasons for including a torque link Describe the torque link and its function **List2** Cause and effect on the nose wheels and leg on the ground Problems e.g. Vibration Poor directional control Speed related Increased tyre wear Methods of shimmy damping: Twin-tread contact tyre Twin wheels mounted on a live axle Mechanical shimmy dampers Hydraulic shimmy dampers **List3** Emphasis on post-installation inspection, test and adjustment: All NWS components Torque link **List4** All components of NWS Torque link.

Learning outcome
The learner will: 7. understand aircraft wheels and tyres
Assessment criteria
The learner can: 7.1 describe the construction of aircraft wheel hubs 7.2 explain how aircraft wheels are designed to prevent tyre creep 7.3 explain the use of fusible plugs in aircraft wheels 7.4 describe dismantling procedures for aircraft wheel/tyre assemblies 7.5 describe inspection procedures on aircraft wheels 7.6 describe aircraft wheel bearings 7.7 describe principal features of typical aircraft tyre types 7.8 describe inspection procedures for aircraft tyres 7.9 describe procedure for inflating aircraft tyres

Range
List1 Basic construction; advantages and disadvantages of: Well-based Loose or detachable flange Divided **List2** Brief explanation **List3** Explanation of how tyres can overheat (e.g. brake fire) Construction of fusible plugs How the fusible plug operates **List4** Preparation (tools, information, equipment) Safety precautions Procedure **List5** Assembled and disassembled wheels Visual Non destructive testing (NDT) Mechanical (e.g. balancing) **List6** Characteristics required of an aircraft wheel bearing Main design features Identifying features and markings Lubrication Installation Visual inspections

Non-destructive Testing (NDT)
Measurements required (side-play, run-out etc.)
Wear limits

List7
Civilian commercial
Military
General aviation
Helicopters
Cross ply ('Bias') and radial (Three Part Nomenclature)
Tubed
Tubeless
Identification codes on tyre walls and their significance:
Size
Date
Serial number
Part number
Ply rating
Speed rating
Fitted rings
Typical operating pressures

List8
Mounted tyres
Mounted tubes
Defects including:
Normal wear to limits
Cuts
Tyre wall damage
Blistering
Delaminating
Flat spot
Excess creep (including monitoring, adverse effects and ways of minimising it)

List9
Preparation (equipment, information, use of charts, graphs etc.)
Safety precautions
Procedure
Explain why correct tyre pressures are important.

Learning outcome
The learner will: 8. understand aircraft brake systems
Assessment criteria
The learner can: 8.1 compare the performance of steel and structural carbon brake units 8.2 describe the layout and function of aircraft hydraulic brake systems 8.3 explain the operation of autobrake systems

8.4 explain anti-skid units
8.5 describe inspection and testing procedures for anti-skid units
8.6 describe installation, adjustment and maintenance operations on aircraft brake systems

Range

List1
Construction
Heat dissipation
Retardation performance
Wear performance

List2
function of the system
Description and function of components:
Brake control valve
Accumulator
Park brake
Anti-skid units
Pressure gauge
Duplicated supply for emergency operation

List3
Purpose
Settings (take-off and landing, level of brake pressure)
Operation
Reversion to pilot control on use of brake pedals

List4
mechanical and electronic describe the principles and function of
General description of:
Mechanical (e.g. Maxaret)
Electronic
More detail of:
Sensors
Actuators
Controls
Indications

List5
Inspection of:
Sensors
Actuators
Electrical cable
Testing:
functional tests
Diagnostic tests

List6

Installation of:
Brake pack
Sensors
Pipe work
Testing of:
Brakes
Anti-skid
Auto brake
Adjustment of:
Sensors
Indication

Learning outcome
The learner will: 9. know passenger aircraft cabin and cargo layouts
Assessment criteria
The learner can: 9.1 identify the legal requirements for emergency equipment in civil aircraft 9.2 describe types of aircraft seat 9.3 describe inspections necessary on aircraft seats and harnesses 9.4 describe cabin layouts for civil passenger aircraft 9.5 describe aircraft galley installations 9.6 describe problems associated with aircraft galleys 9.7 describe cabin entertainment system installations 9.8 describe aircraft cabin safety equipment 9.9 describe cargo loading handling and retention methods

Range
List1 E.g. in: UK Air Navigation Order 2009 Schedule 4 EU Ops subpart k **List2** Including the main differences between them: Flight crew (all stations) Cabin crew Passenger Differences: Harness Mounting Adjustment Functions **List3** Visual Physical

Acceptable limits
Typical faults

List4
Typical arrangements:
Seat arrangement
Location of galley(s)
Location of toilets
Temporary bulkheads
Access to doors
Access to escape hatches
Provision of air stairs
Passenger boarding (access doors, aisles, overhead lockers etc.)

List5
Positioning
Mounting
Ovens
Power supplies
Potable water
Waste
Storage
Refrigeration

List6
E.g.
Corrosion
Overheating
Hygiene

List7
E.g.
Master tape/DVD players
Seat-back displays
Bulkhead displays
Audio installation
Cleaning, inspection, testing

List8
Location, stowage and operation of:
Fire extinguishers
Gloves
Axes
Life jackets
Life rafts
Torches
Loud hailers
Escape slides
Other emergency lighting

List9
E.g. Pallets Containers Manually loaded loose baggage Cargo nets Straps Ball-and-roller floor

Learning outcome
The learner will: 10. be able to undertake practical tasks on aircraft equipment
Assessment criteria
The learner can: 10.1 perform routine tasks on aircraft landing gear 10.2 perform installation tasks on cabin equipment and furnishings

Range
List1 E.g. Main wheel Brake pack Retraction jack Nose wheel steering Main oleo **List2** E.g. Seats Harnesses Cabin trim Galley units

Unit 007 Mechanical systems in aircraft

Supporting information

Guidance

For military candidates outcome 10 can be delivered using military equipment and furnishings (AAES and associated equipment).

Practical assignments and short-answer papers will be set by the Centre using templates and examples provided by City & Guilds and approved by the External Verifier.

This unit covers skills and knowledge that are required in both manufacturing and maintenance processes. It contains the Mechanical Systems part of the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module11A – The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 3
Outcome 2: EASA Level 3 (Except 3 (EASA Level 1))
Outcome 3: EASA Level 3
Outcome 4: EASA Level 3
Outcome 5: EASA Level 3
Outcome 6: EASA Level 3
Outcome 7: EASA Level 3
Outcome 8: EASA Level 3
Outcome 9: EASA Level 1
Outcome 10: Practical – not directly mapped to Part-66 modules

Note: the above list equates to the EASA requirement for category B1 licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 008 Structural materials and components in aircraft

UAN:	R/503/0977
Level:	3
Credit value:	9
GLH:	70
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS - Units 010, 011.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	The aim of the Unit is to provide learners with a detailed understanding of Aircraft Structural Materials and Components. The Unit covers the use of materials, maintenance and manufacturing practices.

Learning outcome
The learner will: 1. know the properties of aircraft ferrous materials
Assessment criteria
The learner can: 1.1 describe how ferrous materials are identified 1.2 describe changes in properties of plain carbon steel during heat treatment processes 1.3 describe changes in properties of plain carbon steel during mechanical working processes 1.4 describe methods of testing ferrous materials

Range
List 1 Properties e.g. Grain structure Alloying elements: All of: Carbon, Chromium, Nickel, Vanadium, Molybdenum, Manganese, Silicon Density Strength Stress Strain Elasticity Ductility

Malleability
Toughness
Hardness
Brittleness
Creep
Fatigue
Work hardening
Corrosion resistance
Hot and cold performance
Marking of stock bars and sheets

List 2
Annealing
Tempering
Quench Hardening
Normalising
Surface hardening
All of; carburising, nitriding, flame hardening, induction hardening

List 3
Hot and cold working
Eg cracks, inclusions and distortions following:
Welding
Casting
Working

List 4
E.g.
Hardness testing
Tensile testing
Impact testing
Fatigue testing
Creep testing

Learning outcome
The learner will: 2. know the properties of aircraft non-ferrous materials
Assessment criteria
The learner can: 2.1 describe how non-ferrous materials are identified 2.2 describe the heat treatment 2.3 describe uses of non-ferrous materials 2.4 describe methods of testing non-ferrous materials

Range
List 1 E.g. Grain structure Common alloying elements - all of: copper, magnesium silicon, zinc Density and strength Stress and strain Elasticity, ductility and malleability Toughness, hardness and brittleness Creep Fatigue Work hardening Corrosion resistance Hot and cold performance Marking of stock bars and sheets **List 2** Annealing Solution treatment Precipitation hardening **List 3** E.g. Structure Skin **List 4** Hardness testing Tensile testing Impact testing Fatigue testing Creep testing

Learning outcome
The learner will: 3. understand corrosion in aircraft materials
Assessment criteria
The learner can: 3.1 describe the chemical fundamentals of corrosion 3.2 describe how corrosion is formed 3.3 describe the types of corrosion and their identification 3.4 explain why materials are susceptible to corrosion 3.5 explain methods to remove and treat corrosion

Range
List 1 E.g. Direct chemical action Galvanic action process **List 2** Environment Wear Stress Microbiological action **List 3** E.g. Surface Pitting Stress Fatigue Intergranular Fretting Crevice Exfoliation Filiform **List 4** E.g. Steels Aluminium alloys Magnesium alloys Copper Silver **List 5** Chemical removal Mechanical removal Restoration of protective finish

Learning outcome
The learner will: 4. be able to repair corroded airframe components
Assessment criteria
The learner can: 4.1 identify defects in ferrous materials 4.2 identify defects in non-ferrous materials 4.3 classify corrosion in aircraft structures 4.4 perform removal and repair of corrosion damage

Range
List 1 Detectable with the naked eye or magnifying glass **List 2** Detectable with the naked eye or magnifying glass Including pipes E.g. cracks, inclusions and distortions following: Welding Casting Working **List 3** Inspect Identify Classify in standard categories **List 4** Plan using standard procedures and repair schemes Repair in non-ferrous material e.g. Remove and blend minor pitting Patch repair Insert repair Protection of repair Inspection of repair

Learning outcome
The learner will: 5. understand the properties of advanced, composite and other non-metallic materials
Assessment criteria
The learner can: 5.1 describe 'advanced' aircraft materials 5.2 describe the heat treatment of advanced aircraft materials 5.3 describe characteristics of aircraft composite materials 5.4 explain the detection of typical defects/deterioration in composite material 5.5 explain repair techniques for composite materials 5.6 describe characteristics of sealants and bonding agents 5.7 describe the characteristics, of non-metallic materials 5.8 explain the preservation of non-metallic materials

Range
List 1 Including uses of e.g. Titanium alloys Aluminium/lithium alloys

List 2
E.g.
Annealing
Hardening

List 3
Properties and identification of:
Glass fibre
Carbon fibre
Boron
Aramid fibre
Typical Resins

List 4
E.g.
Cracking
Warping
Splitting
De-bonding
Delamination
Barely Visible Impact Damage (BVID)

List 5
Pre-preg layup
Wet layup
Fibre orientation
Autoclave
Vacuum bag
Typical repair tools
Safety precautions

List 6
Properties and identification of e.g.
Polyurethane
Silicones
Thread locking compound
Resins
Glues

List 7
Properties and identification of:
Polymers (e.g. thermoplastics, thermosetting, elastomers)
Sandwich construction
Adhesives and glues

List 8
Preservation and maintenance:
Protective treatments
Inspection.

Learning outcome
The learner will: 6. understand general-purpose aircraft components
Assessment criteria
The learner can: 6.1 explain the nomenclature of screw threads 6.2 explain thread systems 6.3 explain the specification system for aircraft bolts 6.4 describe nuts, screws, studs and locking devices used on aircraft 6.5 describe rivet systems 6.6 Describe aircraft pipes and connectors 6.7 describe unions for hydraulic, fuel, pneumatic and oxygen systems 6.8 describe aircraft springs 6.9 describe how springs are inspected and tested 6.10 explain the purpose of bearings 6.11 describe types of aircraft bearing 6.12 describe typical bearing loads 6.13 describe how bearings are typically inspected and tested 6.14 describe types of seal used in aircraft applications

Range
List 1 Crest Form Root Thread angle Pitch Lead Major and minor diameters Depth Threads per inch Single and multi-start threads Right and left hand threads **List 2** ACME Square Buttress Vee threads BSF BSW BA UNF UNC Metric, coarse and fine **List 3** Hexagon head

Cap bolts
Slotted head
High shear bolts
Twelve point head

List 4
Machine Screws
Studs
Washers
Plain nuts
Thin nuts
Slotted nuts
Castellated nuts
Self locking nuts
Washers
Typical thread locking devices
Locking wire
Tab and spring washers
Locking plates
Quick release fasteners
Keys
Circlips
Cotter pins

List 5
Solid and blind rivets
Countersunk and snap head rivets
Describe heat treatment
Typical Riveting tools
Typical defects in riveted joints

List 6
ICAO pipeline symbols
Pipeline construction
Pipe material
Eg – Aluminium alloy, stainless steel, Tungum (bronze copper alloy)
Hose material
E.g. – Plastic, metal, rubber

List 7
E.g.
Flared couplings
Flareless couplings
British metric swaged pipe couplings
American Flareless couplings
Arsaero pipe couplings
Swaged end couplings
Cryogenic pipe couplings
Gamah couplings
Sliding couplings

Quick release connectors
V-flange couplings
Typical pipeline clamping

List 8
Materials
Characteristics
All of – Compression, tension, leaf, torsion
Typical applications

List 9
Testing springs e.g.
Measurement
Load test

List 10
E.g.
Reduce friction and wear
Component alignment

List 11
Materials and construction of:
Plain bearings
Roller bearing
Taper roller bearings
Needle roller bearings
Ball bearings
Thrust bearings
Lubrication
Application

List 12
E.g.
Axial
Radial
Bending (perpendicular to axis)

List 13
E.g.
Types of damage and wear and their causes
Testing methods
Testing criteria

List 14
Types e.g. gaskets, 'O' ring, labyrinth
Applications e.g. gas-tight seals, oil seals, pipe seals

Learning outcome
The learner will: 7. be able to use aircraft fasteners and locking devices
Assessment criteria
The learner can: 7.1 use aircraft fixing devices 7.2 use aircraft locking devices 7.3 use aircraft rivet systems

Range
List 1 A range of devices e.g. Nuts, bolts, screws, studs **List 2** A range of devices including: Lock washers Locking wire Split pins **List 3** Solid and blind rivets Countersunk and snap head rivets Using appropriate riveting tools Inspect for defects in riveted joints

Learning outcome
The learner will: 8. know aircraft control cables and transmission systems
Assessment criteria
The learner can: 8.1 describe aircraft control cable and mechanisms 8.2 describe aircraft pulleys and cable system components 8.3 describe Bowden cables 8.4 describe flexible control systems 8.5 describe gear systems 8.6 describe transmission systems that use belts and pulleys, chains and sprockets

Range
List 1 Cable materials Typical cable end fittings Typical turnbuckles Control stops Typical rigging and maintenance procedures

List 2
Pulleys
Cable tensioning
Tensiometer

List 3
Cable material
Conduit
Typical end fittings
Adjustment
Pull system only

List 4
Teleflex
Conduit
Core cable
Adjustment
Push/Pull systems

List 5
ratios and their application
Spur gears
Helical gears
Bevel gears
Worm gears
Rack and pinion
Application of gears
Driver gear
Driven gear
Idler gears
Gear ratio
Shaft drives
Spline drives

List 6
Drive belts and pulleys
Screw jacks
Sprockets
Chains
Typical applications

Unit 008 Structural materials and components in aircraft

Supporting information

Guidance

Practical assignments and short-answer papers will be set by the Centre using templates and examples provided by City & Guilds and approved by the External Verifier.

This unit covers skills and knowledge that are required in both manufacturing and maintenance processes. It contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 6 – Aircraft Structural Materials and Components , with the exception of 6.3.2-3 (Wood and Fabric Structures) and 6.11 (Electrical cables and Connectors) which is covered in Unit 008 outcome 4. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2 (Testing only – EASA Level 1)
Outcome 2: EASA Level 2 (Testing only – EASA Level 1)
Outcome 3: EASA Level 2
Outcome 4: EASA Level 3 (Except 1(EASA Level 1) and 5-6 (EASA Level 2)
Outcome 5: EASA Level 2
Outcome 6: EASA Level 2
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2

Note: the above List equates to the EASA requirement for category B1 licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 009 Manufacturing aircraft structures

UAN:	R/503/1272
Level:	3
Credit value:	10
GLH:	80
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 Units 001-004, 010, 011
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	The aim of this unit is to provide learners with a detailed understanding of aircraft structures and maintenance practices. It provides knowledge and understanding for a number of NVQ Diploma units and for parts of EASA part66 Module 7A.

Learning outcome
The learner will: 1. understand safety precautions required when working on aircraft and in workshops
Assessment criteria
The learner can: 1.1 explain legislative requirements for aircraft-related workplaces 1.2 explain safe working practices used in aircraft-related workplaces 1.3 explain actions to be taken in workplace emergencies

Range
List1 Health and Safety legislation Environmental protection legislation Hazardous substance legislation **List 2** Aircraft engine intakes, exhausts and propellers Radio wave radiation Hazards eg noise, working at height, manual handling, slips, trips falls Electricity High pressure gases including oxygen Oils Fuels

Chemicals

List 3
With reference to:
First aid fire appliances
First aid
Mains power supplies

Learning outcome
The learner will: 2. understand tools and working practices used on aircraft and in workshops
Assessment criteria
The learner can: 2.1 describe hand and power tools 2.2 describe precision tools and measuring equipment 2.3 describe lubrication methods 2.4 explain the care and control of equipment and spares 2.5 explain quality standards in aircraft manufacture

Range
List1 Hand and power operated including: Spanners Drills Sockets Wrenches Screwdrivers Air tools Electrical equipment **List 2** The calibration, operation, and typical use: Reasons for and importance of calibration Record keeping Labelling of tools Calibration equipment Calibration intervals Calibration standards Calibration process Equipment e.g. Torque loading and torque calibration tools Forming tools such as crimpers Micrometers Verniers Dial test indicators Plug gauges Feeler gauges

Pressure gauges

List 3
Equipment and methods:
Types of lubricant and grades
Oil replenishment equipment
Grease guns

List 4
Tools, workshop materials and aircraft parts:
Tool storage facilities
Tool control systems
Storage of oils and chemicals
Safe storage of aircraft parts and materials
Quarantine and bonded store

List 5
General principles of workshop practice:
Dimensions, allowances and tolerances
Standards of workmanship

Learning outcome
The learner will: 3. understand engineering drawings, diagrams and standards used on aircraft
Assessment criteria
The learner can: 3.1 explain types of engineering drawings 3.2 identify title block and associated information 3.3 explain methods of presenting technical information

Range
List 1 Type of projection (First angle, third angle) Orthographic Isometric ISO, AN, MS, NAS, MIL **List 2** Units and dimensions Scale Title Author Issue number **List 3** E.g. Microfilm

Microfiche Computerised presentation

Learning outcome
The learner will: 4. understand the system of fits and clearances used on aircraft
Assessment criteria
The learner can: 4.1 explain drill sizes for bolts 4.2 explain the common system of fits and clearances 4.3 explain limits of bow, twist and wear 4.4 explain standard methods for checking shaft assemblies

Range
List 1 Pilot drill Tapping drill Clearance drill **List 2** ISO, BS Clearance, Interference, Transition fits **List 3** Ovality Bowing Distortion **List 4** Shafts, bearings, and other associated parts for e.g. Roughness Trueness Wear Structural integrity Corrosion.

Learning outcome
The learner will: 5. understand airframe structures
Assessment criteria
The learner can: 5.1 describe general airworthiness requirements for airframe structures 5.2 describe zonal and station identification systems 5.3 explain stress systems found in aircraft structures 5.4 explain the need for drains and ventilation in structures 5.5 explain how aircraft are protected from static build-up and lightning strikes

5.6 explain aircraft construction 5.7 describe general airframe maintenance tasks

Range
List 1 Classification: primary, secondary and tertiary structure Structural strength Safe life Fail safe Factor of Safety Damage tolerance Truss Monocoque Semi-monocoque **List 2** Zonal systems Airframe stations **List 3** Stress Strain Bending Compression Torsion Tension Hoop stress Fatigue Creep Provision for systems installation **List 4** Water/Moisture traps Drains Contamination Corrosion process **List 5** Methods of bonding components Methods of dissipating static e.g. Static wicks Bonding leads Conductive tyres **List 6** Typical methods and components used in airframe construction: Stressed skin fuselage Formers Stringers

Longerons
Bulkheads
Frames
Struts
Ties
Beams
Floor structures
Methods of skinning
Wing, empennage and engine attachments
Anti-corrosion protection

List 7
Processes and procedures for e.g.
Airframe inspection and testing
Repair of protective coatings
Lubrication
Structural husbandry
Maintenance information and documentation

Learning outcome
The learner will: 6. understand techniques for the assembly and repair of airframe structures and components
Assessment criteria
The learner can: 6.1 describe techniques of airframe structure assembly 6.2 describe methods of surface cleaning and protection 6.3 describe airframe symmetry and alignment checks. 6.4 explain the classification of damage to aircraft materials 6.5 explain visual inspection techniques 6.6 describe corrosion removal, assessment and re-protection methods 6.7 explain general contents of structural repair manuals 6.8 describe deterioration control programmes 6.9 explain non-destructive inspection techniques 6.10 explain disassembly and re-assembly techniques for typical airframe components 6.11 explain troubleshooting techniques applied to aircraft structures

Range
List 1 Use of e.g. Riveting Bonding Threaded fasteners Welding **List 2** Aircraft washing

Post wash lubrication
Chromating
Anodising
Painting

List 3
Symmetry
Alignment
Datum points
Clinometer checks

List 4
Metallic, composite and other aircraft materials:
Classification of damage

List 5
Visual inspection tools and equipment e.g.
Magnifying glass
Strong light
Dye penetrant
X-ray
Describe typical defects e.g.
Impact damage
BVID

List 6
Types of corrosion
Removal methods eg abrasion, chemical
Temporary protective methods
Plating
Excluders
Paint
Primers
Sealants

List 7
E.g.
Standard repair schemes
Standard techniques
Repair limits

List 8
ageing, fatigue and corrosion E.g.
Fatigue monitoring
Flying hours monitoring
Inspections
Service checks

List 9
Visual aids

Penetrant flaw detection
Magnetic particle
Eddy current
Ultrasonics
Radiography

List 10
E.g.
Control surfaces
Pylons
Undercarriage leg
Using:
Locking devices
Jigs
Special tools
Materials

List 11
Nil

Learning outcome
The learner will: 7. be able to use techniques for the assembly airframe structures and components
Assessment criteria
The learner can: 7.1 demonstrate workplace emergency procedures 7.2 perform classification of airframe structures 7.3 perform routine airframe inspections 7.4 apply removal and fitting processes typical airframe components 7.5 assemble sections of airframe structure

Range
List 1 Simulation/walk-through of e.g. Fire evacuation Fuel, oil, chemical spillage Electrical emergency **List 2** Identification and classification of common airframe structures into: Primary Secondary Tertiary **List 3** Visual inspection for damage, corrosion etc Selection and use of inspection and measuring equipment

Selection of information from organisational systems e.g.
Drawings, procedures, checking validity, issue number
Measurement and recording of e.g.
Dimensions
Symmetry
Correct assembly
Integrity of attachments
Surface finish

List 4
E.g.
Control surfaces
Undercarriage components
Nacelles
Tool and equipment selection
Information selection
Correct use of procedures and techniques
Inspection of completed work

List 5
Using metal or composite components
Using methods required by type of structure (e.g. riveting, adhesive bonding etc)
Tool and equipment selection
Information selection
Correct use of procedures and techniques
Inspection of completed work

Learning outcome
The learner will: 8. understand maintenance procedures for the safe and effective operation of aircraft
Assessment criteria
The learner can: 8.1 describe basic operation of a Maintenance Planning department and its interface with aircraft operations 8.2 explain the need for Modification programmes and procedure for implementation 8.3 explain the process for certification and release of aircraft parts and materials 8.4 explain the need for the control of life-limited components 8.5 describe inspection techniques used following lightning strikes and HIRF penetration 8.6 describe inspection techniques used following abnormal events

Range
List 1 IRAN (Inspect and Repair As Necessary) Scheduled maintenance

Preventative maintenance
Anti-deterioration maintenance
Aircraft log books, documentation etc

List 2
Designer modification
Service/Operator modification
Modification leaflets
Technical instructions

List 3
Documentation

List4
Typical life limited components
Documentation

List 5
Avionic/electrical systems
Aerials
Static discharge wick
Skin inspection
Structural inspection

List 6
E.g.
Heavy landing
Bird strike
Hail damage
Tyre burst
Brake fire
Flight through turbulence
Atmospheric contamination

Unit 009 Manufacturing aircraft structures

Supporting information

Guidance

Practical assignments and short-answer papers will be set by the Centre using templates and examples provided by City & Guilds and approved by the External Verifier.

This unit contains the following parts of the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 7– Aircraft Maintenance Practices: 7.1-3, 7.5-, 7.8, 7.10-11 and 7.18-20. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 3
Outcome 2: EASA Level 3
Outcome 3: EASA Level 2
Outcome 4: EASA Level 2
Outcome 5: EASA Level 2
Outcome 6: EASA Level 2 (Except 5 and 6 (EASA Level 3)
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2

Note: the above list equates to the EASA requirement for category B1 licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 010 Electronic and further electrical fundamentals

UAN:	Y/503/1273
Level:	3
Credit value:	9
GLH:	70
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 076 - 085.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner a comprehensive knowledge of electrical and electronic principles in order to understand complex aircraft electrical and electronic systems.

Learning outcome
The learner will: 1. understand electrical and electronic components
Assessment criteria
The learner can: 1.1 describe the properties of resistors 1.2 describe the properties of capacitors 1.3 explain the fundamental laws of magnetism 1.4 explain the fundamental principles of electromagnetic induction 1.5 describe the properties of inductors 1.6 describe the properties of semi-conductor devices

Range
List1 Including: variable resistors, thermistors, carbon, wire-wound, How they are constructed Operating principles including temperature coefficients, conductance, tolerances, limits, Markings and values: colour coding, preferred values, wattage ratings, specific resistance How they are used in circuits; series, parallel, series-parallel including calculations using Ohms and Kirchhoff's Laws Construction of a Wheatstone bridge **List2**

How they are constructed: plates, dielectric, types of capacitor

Operating principles, factors affecting capacitance (area of plates, distance between plates, number of plates, dielectric constant, working voltage, voltage rating

Markings and values: colour coding

How they are used in circuits, including EHTU, calculations of capacitance in series and parallel circuits, charge and discharge, time constants, testing

List3

Basic magnetism: materials, bi-poles, magnetic fields, forces, field around a conductor, action of a magnet in the Earth's magnetic field

Sufficient to understand inductors and transformers

List4

Sufficient to understand inductors and transformers:

List5

How they are constructed

Operating principles

Markings and values

How they are used in circuits

List6

Including:

Diodes, Zener diodes, thyristors, LEDs, photo-electric cells, simple transistors

How they are constructed

Operating principles

Markings and values

How they are used in circuits e.g. diodes: clippers, clampers, full and half-wave rectifiers, bridge rectifiers, voltage multipliers. Transistors: amplifiers, bias, de-coupling, stabilisation, feedback, multi-stage circuits

How they are tested

Vulnerabilities, e.g. ESD, heat

Learning outcome
The learner will: 2. understand transformers, filters and integrated circuits
Assessment criteria
The learner can: 2.1 describe how transformers are constructed 2.2 explain the operation of transformers 2.3 use transformer theory to solve simple design problems 2.4 describe simple filter circuits 2.5 use filter theory to solve design problems 2.6 describe how integrated circuits are constructed 2.7 explain the different types of integrated circuit

Range
List1 Core materials and shapes Windings – materials, primary and secondary coils, turns ratio, voltage tapping **List2** Including: Frequency range and the effects of operating close to or outside limits Power transfer Efficiency, Single and three-phase calculations Auto transformers How outputs can be adjusted to suit specific circuits **List3** E.g. power supplies to specific equipment **List4** High-pass Low-pass Band-pass Band stop **List5** Simple problems e.g. isolation of power supplies from sensitive signal sources **List6** Construction: overview of materials, construction methods and conditions, scale of integration **List7** Including: Operational amplifier Microprocessor Mixed signal EPROM Logic circuits Vulnerabilities e.g. ESD, heat, extreme cold, EMP, excess voltages

Learning outcome
The learner will: 3. understand printed circuit boards
Assessment criteria
The learner can: 3.1 explain the reason for using printed circuit boards 3.2 describe the construction of printed circuit boards 3.3 describe ways in which components can be attached to printed

circuit boards 3.4 describe typical damage and faults to be found on printed circuit boards 3.5 describe applications of printed circuit boards

Range
List1 E.g. generally cheap and easy to produce, repeatable, reliable **List2** Overview e.g. Single and double sided Encapsulated Dielectric and track materials Construction methods: Patterning Lamination Drilling Solder resist etc **List3** E.g. hand soldering, wave soldering, surface mount **List4** E.g. dry joint, cracked dielectric, broken or overheated track **List5** In aircraft equipment

Learning outcome
The learner will: 4. understand servomechanisms
Assessment criteria
The learner can: 4.1 explain terms relating to servomechanisms 4.2 describe servomechanisms 4.3 describe representative aircraft control systems 4.4 describe representative aircraft indication systems

Range
List1 Define: servomechanism, Explain: open loop, closed loop, feedback (positive and negative), follow-up, analogue, transducer, null, damping, dead band, hunting Describe typical faults, effect of reversing synchro leads **List2** Resolvers, differential, control and torque, E&I transformers, inductance

and capacitance transmitters, synchronous transmitters

List3
E.g. flight control systems, air conditioning and pressurisation, engine controls

List4
E.g. engine, electrical power, flap position, cabin conditioning

Learning outcome
The learner will: 5. understand DC circuits and components
Assessment criteria
The learner can: 5.1 explain basic electrical terms 5.2 explain the relationship between current, voltage and resistance 5.3 explain the significance of internal resistance in power supplies 5.4 explain Kirchhoff's Laws of current and voltage 5.5 explain how power is dissipated in DC circuits

Range
List1 Conductors, insulators, current, voltage, resistance, potential difference, electromotive force, conventional current flow, electron flow, conductance **List2** Using Ohms Law calculations **List3** Using worked examples **List 4** Using simple DC circuits **List 5** Power, work and energy Dissipation of power by a resistor Power formula Calculations involving power, work and energy.

Learning outcome
The learner will: 6. understand AC circuits and components
Assessment criteria
The learner can: 6.1 describe the operation of rectifiers 6.2 describe the effects of reservoir capacitors on output voltages

6.3 explain the need to reduce output voltage ripple
6.4 describe the relationship between voltage, current and power in AC circuits
6.5 explain how three-phase AC waveforms can be produced
6.6 use AC circuit theory to solve series and parallel network problem

Range

List1
Half-wave
Bi-phase full-wave
4 diode bridge

List2
E.g. smoothing DC output voltage

List3
E.g. reduce noise in audio amplifiers; eliminate errors in A-D convertors

List4
Resistive, capacitive and inductive circuits
Phase, period, frequency, cycle, amplitude, peak-to-peak value, rms value, average value
By measurement or calculation

List5
Using phasor diagrams only – no calculations required

List6
Using resistive, capacitive and inductive circuits

Learning outcome

The learner will:
7. understand DC generators and motors

Assessment criteria

The learner can:
7.1 explain the magnetic principles used in motors and generators
7.2 explain how electromagnetic induction is used in motors and generators
7.3 explain the operation of series wound generators
7.4 explain the operation of shunt wound generators
7.5 explain the operation of DC compound generators
7.6 explain the requirements for operating DC generators in parallel
7.7 describe the operation of DC series wound motors
7.8 describe the operation and control of DC shunt wound motors
7.9 describe the operation of DC compound motors

Range
List 1 Electromagnets, magnetic fields, forces, field around a current-carrying conductor, magnetic shielding Sufficient to understand generators and motors **List 2** Including: Magneto-motive force, field strength, magnetic flux density, permeability, hysteresis loop, retentivity, coercive force, reluctance, saturation point, eddy currents, Fleming's Left and Right hand Rules, storage of magnets Sufficient to understand motors and generators **List 3** Sufficient to allow understanding of standard aircraft systems– include circuit diagrams E.g. field and armature windings in series, output varies directly with load current, little use practically **List 4** Sufficient to allow understanding of standard aircraft systems– include circuit diagrams E.g. field and armature windings in parallel, output varies inversely with load current Typical aircraft applications **List 5** Sufficient to allow understanding of standard aircraft systems – include circuit diagrams E.g. series and shunt field coils, outputs generally constant in normal operating range Typical aircraft applications **List 6** Sufficient to allow understanding of standard aircraft systems E.g. equalise voltages before paralleling Typical aircraft applications **List 7** Sufficient to allow understanding of standard aircraft systems E.g. generates a large torque, good low-speed operation, moves heavy loads slowly, light loads quickly Typical aircraft applications **List8** Sufficient to allow understanding of standard aircraft systems E.g. good speed and torque control, decreased torque at higher speeds Typical aircraft applications

List 9

Sufficient to allow understanding of standard aircraft systems

E.g. combines characteristics of series and shunt wound, greater torque than shunt motor, more constant speed with varying load

Typical aircraft applications

Learning outcome

The learner will:

8. describe the construction, purpose and function of typical AC generators and motors

Assessment criteria

The learner can:

8.1 describe AC generators

8.2 explain the requirements for operating AC generators in parallel

8.3 describe AC induction motors

8.4 describe AC synchronous motors

Range

List 1

Principles of operation sufficient to allow understanding of standard aircraft systems e.g.

Construction: rotor, stator, slip rings, brush, brushless, salient or non-salient pole, damper windings, excitation

Operation: outputs, control of frequency, voltage (frequency, single phase, multi-phase), load

Typical aircraft applications

List 2

Sufficient to allow understanding of standard aircraft systems e.g.

Synchronisation prior to parallel connection

One generator at a time

Use of a synchroscope

Typical aircraft applications

List 3

Construction and operation sufficient to allow understanding of standard aircraft systems e.g. rotor, stator

Squirrel cage rotor

Phase splitting (single-phase AC induction motor)

Typical aircraft applications

List 4

Construction and operation sufficient to allow understanding of standard aircraft systems e.g. stator, rotor, windings, slip rings

The need for a starting device

Field excitation

Typical aircraft applications

Learning outcome
The learner will: 9. be able to construct and test working electronic circuits
Assessment criteria
The learner can: 9.1 construct simple circuits to prove Ohm's and Kirchhoff's Laws 9.2 demonstrate the relationship between voltage, current and power in AC circuits 9.3 construct and test smoothed and stabilised power supplies

Range
List 1 Using a variety of components, from a circuit diagram, assembled and tested **List 2** Using a variety of components, from a circuit diagram, assembled and tested Demonstrate AC waveforms Measure a range of parameters (e.g. phase, p-p and peak values) Demonstrate the use of phasor representation of sinusoidal quantities **List 3** Using a variety of components, from a circuit diagram, assembled and tested Demonstrate varying degrees of smoothing

Unit 010 Electronic and further electrical fundamentals

Supporting information

Guidance

Practical assignments and short-answer papers will be set by the Centre using templates and examples provided by City & Guilds and approved by the External Verifier.

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 3 – Electrical Fundamentals (except 3.1-3 and 3.4-5, which are covered in unit 006), and the whole of Module 4 – Electronic Fundamentals. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B2 category - are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 2 (Advanced resistors – EASA Level 1)
Outcome 2: EASA Level 2 (4 and 5 – EASA Level 1)
Outcome 3: EASA Level 2
Outcome 4: EASA Level 2
Outcome 5: EASA Level 2
Outcome 6: EASA Level 2
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 2

Note: the above list equates to the EASA requirement for category B2 licences and is for guidance only. It exceeds the requirement for the B1 category for Modules 3 and 4. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 011 Aircraft electrical systems

UAN:	D/503/1274
Level:	3
Credit value:	10
GLH:	80
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 62-88.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner a comprehensive understanding of aircraft electrical systems, applying basic principles previously learned.

Learning outcome
The learner will: 1. understand aircraft instrumentation and air data systems
Assessment criteria
The learner can: 1.1 explain the need for aircraft instrumentation 1.2 explain the operation of pitot-static systems 1.3 describe pitot-static system components 1.4 describe standard procedures for pitot-static system functional checks 1.5 explain how outputs are computed within an air data system 1.6 explain instrumentation system sensors 1.7 describe the layout of aircraft engine indication systems 1.8 describe test equipment for a range of indicating systems

Range
List1 E.g. in terms of: physiological limitations of a (human) pilot (unable to sense speed, height, altitude etc. accurately or safely), complexity of aircraft requires accurate data for display and to compute control signals **List2** Define pitot and static pressure Operation e.g. outputs required, available quantities to measure, method of measurement of each, method of displaying or otherwise using each parameter (e.g. altimeter, mach meter, ASI, VSI)

List3

Precision pressure indicators

Digital pressure indicators

Vacuum and differential pressure chambers

List4

Including: safety precautions, precautions to prevent damage to or contamination of the system, test equipment (manual and automatic), blanks, bungs and adaptors

List5

Altitude, vertical speed, indicated airspeed (IAS), true airspeed (TAS), Mach number

List6

Pressure transducers, total temperature probe, angle of attack probe, accelerometer

List7

E.g. temperatures (EGT, oil), pressures (EPR, oil), RPM, fuel flow and inlet pressure, oil quantity, filter bypass (oil and fuel), fuel heat, engine start, vibration, reverse thrust

List8

Fluid pressure

Position indication

Engine speed

Cabin temperature

Engine temperature

Fuel contents

Fuel flow

Learning outcome
The learner will: 2. understand aircraft flying control systems
Assessment criteria
The learner can: 2.1 explain how servomechanisms operate 2.2 explain how control, indication and positioning systems operate 2.3 explain how compensation is applied to RPC servo systems 2.4 explain how digital and analogue techniques are applied to control systems 2.5 explain the operation of a fly-by-wire system 2.6 explain the operation of a basic autopilot 2.7 explain how inputs from external systems contribute to autopilot operation

Range
List1 Including: Servomechanism, open loop, closed loop, feedback (positive and negative), follow-up, analogue, transducer, null, damping, dead band, hunting, resolvers, differential, control and torque, E&I transformers, inductance and capacitance transmitters, synchronous transmitters **List2** E.g. Control: primary and secondary flight controls, trim Indication: flap/slat position, trim position, autopilot engaged Positioning: remote position control (RPC) – open and closed loop **List3** E.g. error rate, transient, integral **List4** E.g. input, feedback, signal processing **List5** Illustrate using block and signal flow diagrams **List6** Illustrate In auto-stab and 'control wheel steering' modes Modes of operation: roll, pitch and yaw channels **List7** Illustrate Using block and signal flow diagrams Inputs from e.g. compass, air data, radio, radar, INS Auto throttle, Automatic landing systems: principles, modes of operation, approach, glideslope, land, go-around, system monitors, failure conditions

Learning outcome
The learner will: 3. understand aircraft power supply systems
Assessment criteria
The learner can: 3.1 explain the requirements of aircraft power supply systems 3.2 explain the purpose of aircraft electrical system components 3.3 explain aircraft electrical distribution panels 3.4 explain aircraft bus bars 3.5 explain circuit breakers and fuses 3.6 explain manual and automatic switches 3.7 describe terminal blocks in aircraft electrical circuits

Range
List1 E.g. primary, secondary, emergency, redundancy, load shedding, real and apparent power **List2** E.g. generators, cable, panels, batteries, invertors, bus power control unit **List3** Purpose and typical location **List4** Types, classifications and purposes **List5** Purpose and operating principles **List6** Purpose and operating principles of e.g. micro-switches, sequence timers, purpose of caged and guarded switches **List7** The application and purpose of e.g. power and signal distribution.

Learning outcome
The learner will: 4. understand aircraft lighting and warning systems
Assessment criteria
The learner can: 4.1 describe types of lamp used on aircraft 4.2 describe the hazards and safety precautions associated with aircraft lamps 4.3 explain aircraft lighting systems 4.4 describe safety aspects of operating aircraft lighting systems 4.5 explain aircraft visual and audible warning systems

Range
List1 E.g. high intensity strobes, identification lights, miniature bulbs, fibre optics, halogen, LED, fluorescent **List2** E.g. handling, checking ratings; checking power supplies, switches and circuit breakers, disposal **List3**

Internal and external, purpose and operation e.g.
Cabin, cockpit, cargo and equipment bays
External identification
Landing lights
Ice detection

List4
E.g. high intensity, particularly at night, high voltage (strobes), lack of light dangerous to others

List5
Purpose and function of e.g.
Advisory, emergency
Centralised warning panels
Master warning system indicating unseen state of equipment (e.g. undercarriage movement, position, locked/unlocked, flaps travelling)
Stall warning
Angle of attack indication and warning
Proximity warning
Fire Panel.

Learning outcome
The learner will: 5. understand aircraft cabling and bonding
Assessment criteria
The learner can: 5.1 explain aircraft primary and secondary bonding 5.2 describe procedures for maintaining aircraft earth and bonding points 5.3 explain insulation testing of aircraft wiring assemblies

Range
List 1 Define primary and secondary bonding Explain the purpose and principles: Prevent static build-up Provide lightning discharge paths Bond aircraft to earth etc during refuelling Explain bonding methods Explain effects of poor bonding (interference with radio, intercom etc) **List 2** E.g. inspection Common faults (loose connection, corrosion, broken bonding lead) Cleaning, repair, protection **List 3** Purpose e.g. Deterioration of aircraft cable insulation

Mechanical and chemical/environmental damage
Need to maintain insulation within tightly packed looms
Methods e.g.
Bonding testers
Disconnection of sensitive equipment prior to test
Possible errors
Dangers to personnel/equipment

Learning outcome
The learner will: 6. understand aircraft engine electrical systems
Assessment criteria
The learner can: 6.1 explain Airborne Auxiliary Power Units (AAPU) 6.2 describe aircraft gas turbine engine starting systems 6.3 describe aircraft gas turbine engine ignition systems 6.4 explain aircraft engine control systems

Range

List 1
Purpose e.g.
Requirement for airborne and ground auxiliary power
Principle of operation e.g.
Outputs (electrical, hydraulic, pneumatic)
Types of motive power e.g. ram air, gas turbine engine
Methods of driving generators and obtaining electrical power

List 2
Requirements for a starting system e.g. generate large amounts of torque
Components, function and principles of operation e.g.
Types of starting system e.g. air, electrical, hydraulic
Basic terms – starter generator dealt with in outcome 7

List 3
Components, function and principles of operation of a typical e.g.
How and where fuel is burned
Need for reliable ignition source
HEIU, igniters
Start sequence

List 4
Purpose and principle of operation e.g.
Parameters that require controlling to sustain useable power
How it is controlled
Sensors, inputs, outputs,
Types of controller including FADEC

Learning outcome
The learner will: 7. understand aircraft primary and secondary power sources
Assessment criteria
The learner can: 7.1 explain single generator systems 7.2 explain multi-generator/starter systems 7.3 explain non-paralleling AC generator systems 7.4 explain paralleling AC generator systems 7.5 explain AC generator drive systems 7.6 explain static inverters 7.7 explain transformer rectifier units

Range
List 1 Including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, switching **List 2** Including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, switching **List 3** Including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, switching **List 4** Including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, switching **List 5** Including: requirements of a drive system, constant speed drive, source of motive power, location of drive unit, method of coupling and transmission, safety devices **List 6** Including: requirement to convert DC to AC electronically (under what circumstances), how it is done – power source, basic circuit and output waveforms **List 7** Including: requirement to convert primary AC to 28v DC, how it is done – power sources, basic circuit, output waveform (stability, low harmonic content, EMI filtering)

Learning outcome
The learner will: 8. be able to carry out installation and testing on aircraft electrical systems

Assessment criteria
The learner can: 8.1 perform routine testing of aircraft instrumentation systems 8.2 assist with the operation of flying control systems 8.3 perform tasks on aircraft flying controls 8.4 test aircraft auto-stabilisation systems 8.5 perform removal and installation of aircraft lighting and warning system components

Range
List1 Identify instrumentation components Connect and operate test equipment Read and interpret instruments Remove and fit system components System e.g. pitot-static, engine indication, cabin conditioning **List 2** E.g. functional checks, range of movement, flap travel times **List 3** In accordance with aircraft manuals E.g. fit/remove flying control surfaces, actuators, switches, sensors **List 4** Test a representative auto stabilisation system accordance with aircraft manuals. **List5** E.g. lamp, circuit breakers, fuse/fuse holders, switches, warning horn

Unit 011 Aircraft electrical systems

Supporting information

Guidance

This unit contains parts of the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 11, 13 and15, but it should be taught in the context of installation, system test and repair during the manufacturing process. Knowledge of system components, layout, purpose and function should be taught in the context of installation of new systems rather than the maintenance of in-service systems.

Unit 012 Installing aircraft electrical cables

UAN:	M/5031280
Level:	3
Credit value:	9
GLH:	70
Relationship to NOS:	This unit is linked to the Aeronautical Engineering Level 3 NOS Units 062, 076, 086-088.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	The aim of this unit is to give the learner a detailed understanding of the process of preparing, installing and testing aircraft wiring and electrical and avionics equipment in a manufacturing environment.

Learning outcome
The learner will: 1. understand workshop safety, tool selection and tool control
Assessment criteria
The learner can: 1.1 describe fire precautions and procedures in a workshop environment 1.2 describe compressed gas precautions and procedures in a workshop environment 1.3 describe oil and chemical precautions and procedures in a workshop environment 1.4 describe safe working procedures in a workshop environment 1.5 describe tool and material control procedures in a workshop environment 1.6 describe tools used in aircraft electrical installation work 1.7 describe standards of electrical and avionic work 1.8 describe the system of fits and clearances used in aircraft engineering

Range
List 1 Knowledge of precautions in both training environment and typical workplace environments such as: Composite production, wiring shops, aircraft major component

assembly, (fuselage, wings etc), clean rooms
emergency procedures e.g. tackling small fires, evacuation

List 2
Knowledge of precautions in both training environment and typical workplace environments such as:
Composite production, wiring shops, aircraft major component assembly, (fuselage, wings etc), clean rooms, confined spaces
Demonstrate knowledge of emergency procedures e.g. minor incidents, evacuation

List 3
Knowledge of precautions in both training environment and typical workplace environments such as:
Composite production, wiring shops, aircraft major component assembly, (fuselage, wings etc), clean rooms, confined spaces
Demonstrate knowledge of emergency procedures e.g. tackling small spillages, evacuation

List 4
Safe use of e.g. standard hand tools (saw, hammer, file, pliers etc), specialist tools (hot and mechanical wire strippers, heat gun, knife, crimp tools etc.), power tools (drill, power driver etc.), lubrication tools

List 5
Tools including: shadow boards, personal tool kits, automatic tool check, tool inspection, renewal and calibration, personal discipline, responsibility to report losses and damage
Materials including: ordering and issue of large (eg sheet material) and small (e.g. nuts, bolts, washers) items, responsibility to check before use

List 6
how they are used and maintained Inspection, calibration and care of e.g.
strippers, crimp tools (mechanical and hydraulic), cutters, wire gauges, go/no-go gauges, heat shrink guns, marking and sleeving equipment, wrapping tools, torque drivers

List 7
Correct methods of work, dimensions, tolerances, allowances

List 8
With respect to electrical and avionics equipment, an overview of:
Drill sizes for bolt holes, classes of fits
Common system of fits and clearances
Schedule of fits and clearances for aircraft equipment
Limits for bow, twist and wear
Standard methods of checking shafts, bearings and other common parts (e.g. in generators and motors).

Learning outcome
The learner will: 2. understand standards for engineering drawings in the aviation industry
Assessment criteria
The learner can: 2.1 describe the main types of aircraft engineering drawings 2.2 describe how drawings are uniquely identified and maintained up to date 2.3 describe features of other common drawing standards used in the aviation industry 2.4 explain the use of wiring diagrams, tables and other schematic diagrams used in aircraft electrical and avionics systems

Range
List 1 The features and uses of each type using information from CAA CAP562 Leaflet 2-1or equivalent documents Including BS8888 general symbols and conventions, local approved standards where applicable (detailed where applicable to electrical systems, overview of important other items) **List 2** Including information in CAA CAP562 Leaflet 2-1or equivalent documents **List 3** Overview of e.g. ISO, Mil, AN, MS, NAS, ATA Spec100 **List 4** Including presentation methods: paper, computer, microfilm/fiche

Learning outcome
The learner will: 3. know inspection and quality assurance procedures in aircraft manufacture
Assessment criteria
The learner can: 3.1 describe the organisation of quality departments in aircraft manufacturing organisations 3.2 describe stores facilities in aircraft manufacturing organisations 3.3 describe defects that may be found during inspection of aircraft and associated equipment 3.4 describe inspection techniques used to find defects in aircraft 3.5 describe trouble-shooting techniques 3.6 describe assembly and disassembly techniques 3.7 explain the principles of aircraft modification 3.8 explain the life-limitation of aircraft components 3.9 describe how to inspect aircraft following unusual events

3.10 explain the principles of aircraft Centre of Gravity calculations

Range
List 1 Including: compliance, auditing, inspection, training **List 2** General knowledge of function and responsibilities including: procurement and control of: Tools Spares and materials Bonded store Quarantine **List 3** Overview of: structural defects (e.g. cracks, skin damage, corrosion), mechanical system defects (e.g. broken or chafed pipes, fluid leaks, signs of overheating) Detail of: electrical/avionic equipment damage (external, signs of overheating, damaged cooling ducts), wiring defects (e.g. wrongly routed, chaffed, overheated cable or terminations, impact or chemical damage, corrosion, ageing, wrongly labelled), bonding defects (e.g. corrosion, poorly sited, incorrect fasteners – type or material) **List 4** Overview of techniques for mechanical inspection e.g. NDT (x-ray, ultrasonic, visual, borescope); destructive e.g. removal of skin; functional and performance testing Detail of techniques for electrical, avionics and wiring e.g. visual inspection, electrical testing (programmable loom testing, TDR, insulation testing), functional and performance testing) **List 5** E.g. half-split, signal injection, input/output, functional and diagnostic test, self test/check **List 6** Emphasis on electrical wiring and equipment e.g. connector blocks, panels, connector blocks, multi-way connectors Techniques e.g. use of correct tools; anti-seize fluids; care of loose items; marking items for re-assembly; replacing single-use, lifed and worn items, protection of re-assembled items **List 7** Using an appropriate regulatory framework e.g. EASA, CAA, Mil: Typical reasons for modifications Design and approval procedure – overview Modification procedures – typical electrical/avionics Recording and marking modified items **List 8** Reasons for life-limitation

Control of lifed items

List 9

Overview of: lightning strike, HIRF, heavy landing, excessive turbulence

List 10

General knowledge of the reasons for the calculations e.g.
Effects on aircraft performance of C of G position, safe limits
How the measurements and calculations are done
Use of the relevant documents

Learning outcome
The learner will: 4. understand types of aircraft electrical cable
Assessment criteria
The learner can: 4.1 describe electrical and environmental challenges to aircraft electrical wiring 4.2 describe cable types used in aircraft electrical power supply systems 4.3 describe cable types used in aircraft digital systems 4.4 describe cable types used in aircraft communication systems 4.5 describe fibre-optic cable used in aircraft systems

Range
List 1 E.g. overheating due to excessive current, poor cooling, poor connections, chemical contamination, deterioration and damage to insulation, water ingress/absorption, mechanical damage due to abrasion, poor routing and excessive pull-through forces **List 2** Including: insulation and conductor materials, size and capacity, main manufacturers and users Physical properties including mechanical and insulation performance, relative safety in challenging environments, uses in specific applications **List 3** Including: insulation and conductor materials, size and capacity, main manufacturers and users Physical properties including mechanical and insulation performance, relative safety in challenging environments, uses in specific applications **List 4** Including: insulation and conductor materials, size and capacity, main manufacturers and users Physical properties including mechanical and insulation performance, relative safety in challenging environments, uses in specific applications **List 5**

Including: materials, construction, size and signal capacity

Physical properties including mechanical performance, relative safety in challenging environments, uses in specific applications (e.g. lighting, flight controls, data transmission).

Learning outcome

The learner will:

5. understand how aircraft cable is prepared and terminated

Assessment criteria

The learner can:

5.1 describe the preparation of typical aircraft cable for crimping

5.2 describe the preparation of typical aircraft cable for soldering

5.3 describe the termination of typical aircraft cable by crimping

5.4 describe the termination of typical aircraft cable by soldering

5.5 describe the preparation and assembly of a range of electrical connectors

5.6 describe the termination of aircraft fibre optic cable

Range

List1

Use of a range of preparation tools

Including pre-use checks, calibration and function, information on length of bared conductor

List2

Use of a range of preparation tools

Including pre-use checks (calibration and function), information on length of bared conductor etc, selection of soldering iron and solder (include Health and Safety considerations), sleeving and labelling

List3

Use of a range of Precision Termination Tools (PTT), e.g. sub-miniature connectors, hydraulic crimp for heavy duty power cable, different manufacturers

Including pre-use checks (calibration and function), correct use of the PTT, inspection of finished termination, heat-shrink and labelling

Describe how the PTT works and what the termination should look like when complete; points to watch for indicating a poor termination, diagnosing PTT faults

List4

Use of a range of soldering iron bits and other soldering tools

Including pre-use checks (calibration and function), correct use of solder, flux and heat source, inspection of finished joint

Describe how the solder works and what it should look like when complete; points to watch for indicating a poor joint, diagnosing soldering faults

List5

Including power and signal connectors, multi-pin, co-axial, data

Explaining and demonstrating selection of connectors, sealing, environmental protection, potting, strain relief, orientation, and use of pin insert/extractors

Explain the safety precautions for typical potting compound

List6

Explain the vulnerabilities of fibre-optic cable and its physical limitations

Pre-use checks on termination equipment (blade, polishing materials, gauges etc.)

Learning outcome
The learner will: 6. understand how aircraft cable is installed and repaired
Assessment criteria
The learner can: 6.1 describe effects on individual cables when bunched together in wiring looms 6.2 describe techniques used in the manufacture of aircraft cable assemblies 6.3 describe how aircraft wiring is installed and secured in place 6.4 describe how aircraft wiring is inspected and maintained in-service 6.5 describe techniques used in the repair of aircraft cable assemblies

Range

List1

E.g. reduced heat dissipation, interacting fields, creating capacitive interference between power and signals, chemical interaction between insulation materials

Methods of eliminating or minimising adverse effects e.g. screening, separation of cable and signal types

List2

E.g. wrapping, lacing, sleeving, potting, crimping, profiling, strain relief, testing of crimp joints

List3

Precautions when working with aircraft wiring, safe handling of wiring and electrical assemblies

Methods of protection and support for aircraft wiring assemblies

Carry out typical installation work in a real or simulated environment

List4

Inspection methods, typical defects, causes of typical defects and their remedies

Inspect a typical installation and report findings

Describe repair criteria and methods

List5

Describe typical regulatory requirements for cable repair e.g. CAA, EASA, Mil

Repair typical defects by in-line crimp and wire replacement

Learning outcome
The learner will: 7. understand the electrical bonding of aircraft structure
Assessment criteria
The learner can: 7.1 explain why aircraft structure needs to be electrically bonded 7.2 describe methods used to electrically bond metal airframe structure 7.3 describe methods used to electrically bond composite aircraft structure 7.4 describe methods used to test and inspect electrical bonding

Range
List1 E.g. prevention of static build-up and arcing (e.g. in fuel tanks), reduction of signal noise, lightning protection, provide earthing points for refuelling, ground power etc. **List2** Including: locations, accessibility, fasteners, bonding straps, materials, protection of bonding points **List3** Including: locations, accessibility, fasteners, bonding straps, materials, bonding of external antennae (e.g. use of backplanes), protection of bonding points **List4** Inspection including: broken or damaged bonding straps, corrosion of terminations and surrounding areas, potential for damage of newly installed bonding, typical bonding resistance values Testing including: intrinsically safe test equipment, dangerous environments such as fuel tanks, removal of electrical power, disconnection of sensitive equipment

Learning outcome
The learner will: 8. be able to use electrical wiring maintenance and testing techniques
Assessment criteria
The learner can: 8.1 demonstrate workplace emergency procedures 8.2 demonstrate workshop procedures 8.3 demonstrate how aircraft cable is prepared and terminated 8.4 demonstrate how aircraft wiring is installed and secured in place 8.5 interpret wiring diagrams, tables and other schematic diagrams used in aircraft electrical and avionics systems 8.6 demonstrate techniques used in the manufacture of aircraft cable assemblies

8.7 inspect aircraft cable looms
8.8 demonstrate fault finding techniques
8.9 demonstrate techniques used in the repair of aircraft cable assemblies
8.10 test wiring installations using approved test equipment
8.11 install and test electrical bonding on structural components
8.12 functionally test avionic equipment

Range

List 1
Simulation/walk-through of e.g.
Fire evacuation
Fuel, oil, chemical spillage
Electrical emergency

List 2
Safety
Tool selection
Tool control
Materials and spares control

List 3
E.g.
Crimping (cutting, stripping, fitting terminations)
Soldering (cutting, stripping, fitting terminations)
Fibre Optic cables and terminations (cutting, polishing, fitting connectors)
Preparation and assembly of a range of electrical connectors e.g.
HT
Power
Signal
Data

List 4
E.g.
Troughs
Conduits
Cable ties

List 5
Conforming to one or more standards
Military or Civil

List 6
Construct sample cable looms using a range of cable types, terminations and connectors e.g.
Electrical
Signal
Data

Communications

List 7

E.g.

Visual

Testing

List 8

Using standard fault finding methods and equipment e.g.

Wiring faults

Basic electrical system faults

Basic avionic system faults

Using e.g. pitot-static leak tester, digital and analogue multi-meters, bonding and insulation tester, continuity tester, VSWR meter, Time Domain Reflectometer (TDR), manually set special-to-type test equipment

List 9

E.g.

In-line crimps

Replacement of one cable in a bundle

List 10

E.g.

Continuity tester

Insulation tester

Programmable loom tester

List 11

Demonstrate the electrical bonding of aircraft metal or composite structure

Select and use correct fasteners, locking devices, bonding straps, protective coatings

Prepare surfaces, holes etc

Install bonding and apply protective coating

List 12

On or off aircraft

Avionic or electrical system or component e.g.

Altimeter, ASI, VSI

Transformer/rectifier unit

Lighting systems

Unit 012 Installing aircraft electrical cables

Supporting information

Guidance

Practical assignments and short-answer papers will be set by the Centre using templates and examples provided by City & Guilds and approved by the External Verifier.

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 7 – Maintenance Principles. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B2 category - are listed below with an abridged description of each level:

- Level 1 – "A familiarisation with the principal elements of the subject"
- Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"
- Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

Outcome 1: EASA Level 3 (9 – EASA Level 1)
Outcome 2: EASA Level 2
Outcome 3: EASA Level 2
Outcome 4: EASA Level 2
Outcome 5: EASA Level 2
Outcome 6: EASA Level 2
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 3

Note: the above list equates to the EASA requirement for category B2 licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

This unit covers the fundamentals of aircraft wiring installation and is generic enough for providers to adapt to their own particular resources and local employer requirements. It should be taught according to the current regulatory requirements, and is flexible enough to take account of new materials, equipment and methods that will be introduced and approved from time-to-time. The vast range of equipment and associated test gear make it impossible to define a list of equipment to train on, similarly the cable and connector types are very numerous. The knowledge 'range' should include typical avionics and electrical equipment that is relevant to the learner's possible future employment, plus added items to give a broad range where necessary. The practical 'range' should be both relevant and feasible and, because of the high value of many items, will depend upon accessibility.

Note: It is impossible to cover every type of cable in Learning outcome 4. Learners should be taught a range of cables that is relevant to their individual needs. It is important not to concentrate exclusively on the cable types used by one particular aircraft manufacturer, rather to learn about similar alternatives.

Unit 013 Fundamentals of aircraft composite materials

UAN:	A/503/1282
Level:	2
Credit value:	2
GLH:	15
Relationship to NOS:	This unit is linked to the Level 2 Aeronautical Engineering NOS Units 026, 029
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to provide the learner with a basic knowledge of composite materials for use in current and future aircraft.

Learning outcome
The learner will: 1. know the meaning and application of aircraft composite materials
Assessment criteria
The learner can: 1.1 identify key composite materials 1.2 state the properties of aircraft composite materials 1.3 state the application of aircraft composite materials 1.4 identify advantages and disadvantages of aircraft composites

Range
List1 Composite materials: Carbon fibre Glass fibre Aramid fibre Quartz fibre Sandwich materials Laminate materials Aluminium **List2** strength/weight ratio fatigue life corrosion resistance conductivity

strength
impact resistance
rapid temperature change

List3
wing covers
fairings
floorboards
vertical/horizontal stabiliser
spars
ribs

List4
Composite materials:
Carbon fibre
Glass fibre
Aramid fibre
Quartz fibre
Sandwich materials
Laminate materials)

Learning outcome
The learner will: 2. know how fibres are produced and used to form aircraft composite structures
Assessment criteria
The learner can: 2.1 describe how composite fibre materials are used to produce finished components 2.2 identify the importance of fibre arrangement within composite structures 2.3 identify key materials used to form matrices 2.4 identify key processes used to form composite structures

Range
List1 Filament Tow Strand Mat Woven fabric Lamina Matrix **List2** Fibre orientation: Random Unidirectional stack Woven: (Plain weave, Basket weave)

List3
Epoxy resin
Polyester
Phenolic
Vinyl esters

List4
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 safety procedures associated with composite materials in aircraft applications
Assessment criteria
The learner can: 3.1 describe hazards and risks associated with the processing of composite materials 3.2 describe hazards and risks associated with handling composite materials 3.3 describe safety precautions used when processing and handling composite materials

Range

List1
Personal: ingestion and inhalation, skin damage and allergy
Risks to materials: contaminants (F.O.D Foreign Object Damage, water, chemicals)
Risks to environment: fire and explosion, contamination

List2
Personal: dust, particulates and fibres, splinters
Risks to components: impact damage, contaminants

List3
Health and Safety legislation, manufacturer's information, Codes of Practice
Use of PPE
Equipment: fume/dust extraction
Safe disposal of waste
Safe transport
Storage.

Unit 013 Fundamentals of aircraft composite materials

Supporting information

Guidance

This unit forms part of the Airbus composites training programme and can be used by any organisation wishing to improve the knowledge of composites and their application in aerospace and other industries. Learning materials can be contextualised and the unit can be used as a basis for bespoke training courses.

Unit 017 Manual drilling of aircraft composite materials

UAN:	J/503/1284
Level:	2
Credit value:	4
GLH:	30
Relationship to NOS:	This unit is linked to the Level 2 Aeronautical Engineering NOS Units 013, 028
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner knowledge and practical skills in the specialist drilling of aircraft composite materials.

Learning outcome
The learner will: 1. be able to mark out and position composite components prior to manual drilling
Assessment criteria
The learner can: 1.1 identify the marking media and equipment used on aircraft composite materials 1.2 identify data from documentation 1.3 apply marking out procedures to composite materials

Range
List1 Media: approved marker pen Equipment: e.g. square, ruler, vernier instruments, holding devices (jigs, clamps) **List2** Data: reference point, orientation, pitch, land Documentation: drawings, standards, procedures **List3** Prepare components: cleaning, degreasing, positioning, securing Mark out using: marking media, equipment, documentation Check: dimensions to data from documentation

Learning outcome
The learner will: 2. know manual equipment used for drilling holes in aircraft composite materials
Assessment criteria
The learner can: 2.1 describe types of manual drilling equipment 2.2 describe applications of manual drilling equipment 2.3 describe health and safety procedures for drilling and finishing holes in composites

Range
List1 Machines: e.g. portable orbital drill, pneumatic pistol drill Cutting tools: e.g. drills, reamers, countersinks, combined drill/countersink, de-burring tools. **List2** Application of machines: e.g. restricted access (90°, 30° etc), stack drilling Application of cutting tools: e.g. pilot drill, reamer, countersink, combined drill/countersink, de-burring tools. **List3** Personal protection: e.g. PPE (dust, fumes, noise), safety equipment use, confined spaces Material protection: e.g. surface finish, impact damage, contaminants

Learning outcome
The learner will: 3. be able to drill and finish holes in aircraft composite materials
Assessment criteria
The learner can: 3.1 interpret production documentation 3.2 select cutting tools and equipment 3.3 prepare work-pieces 3.4 prepare cutting tools and equipment 3.5 produce finished holes in work-pieces 3.6 carry out inspection of work-pieces

Range
List1 E.g. Methods, standards, drawings, instructions, risk assessments, COSHH reports **List2** Materials: factoring in composite material type, composite material thickness, composite material shape, composite material construction

Equipment: e.g. jigs, fixtures and drill blocks, securing devices, cutting tools, coolant, safety equipment, P.P.E (Personal Protective Equipment)

List3

Composite materials: cleanliness checks, sizes of holes to be produced, measurement of 'marking out' positions, thickness of stack, composite materials in the stack

List4

Check: equipment condition, calibration dates, speeds and feeds, safety equipment,

cutting tool type, jigs, fixtures and drill blocks, cutting tool assembly and adjustment

List5

Cutting action of drills: e.g. cutting angles, avoidance of excess heat generation, reaction of material to localised heat, avoidance of breakthrough and delamination, use of coolants

Cutting action of reamers and countersink cages: e.g. feeds and speeds, avoidance of excess heat generation, reaction of material to localised heat, use of coolants

List6

Work-piece inspection: hole geometry and positioning, ovality, surface finish, breakthrough and delamination

Inspection equipment: e.g. plug gauges, surface comparison plates, NDT specific equipment (e.g. visual), magnifying glass, appropriate precision measuring equipment

Documentation: e.g. inspection reports, tracking log, correct labelling

Learning outcome
The learner will: 4. know the faults and reporting procedures associated with drilling aircraft composites
Assessment criteria
The learner can: 4.1 describe faults in drilled and finished hole dimensions 4.2 describe causes of drilling and finishing faults 4.3 state reasons for reporting defects

Range
List1 Out of tolerance: diameter, ovality, taper, countersink (CSK) angle, CSK depth, alignment, surface finish Peripheral damage to surrounding skin: burrs, chips, fraying, burning, breakout damage, delamination

List2

Out of tolerance: damaged and worn tooling, incorrect feeds and speeds, incorrect or insufficient coolant, incorrect tool and equipment selection

Peripheral damage to surrounding skin: miss-handling of material

List3

Materials defects: e.g. operational safety, failure of components, component unsuitable for tasks, limited visibility of the extent of damage or defect N.D.T (None Destructive Testing) requests, avoiding unnecessary re-work to materials

Cutting tools and equipment: e.g. worn and damaged tools of fixtures of jigs and equipment, incorrect use of tools and equipment, faulty or incorrect use of safety equipment, misalignment,

Documentation: e.g. incorrect issue, misinterpretation of documentation, incomplete documentation, no risk assessment or relevant COSHH information and procedures, documentation inaccuracies.

Unit 017 Manual drilling of aircraft composite materials

Supporting information

Guidance

This unit forms part of the Airbus composites training programme and can be used by any organisation wishing to improve the knowledge and understanding of composites and their application in aerospace and other industries. Learning materials can be contextualised and the unit can be used as a basis for bespoke training courses.

Assessment is by a centre-set practical assignment multi-choice question paper.

Unit 019 Installing shims in aircraft composite structures

UAN:	L/503/1285
Level:	3
Credit value:	4
GLH:	30
Relationship to NOS:	This unit is linked to the Level 3 Aeronautical Engineering NOS Units 019- 029.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims to give the learner knowledge and practical skills in the installation of shims during the assembly of aircraft components manufactured from composite materials.

Learning outcome
The learner will: 1. understand the importance of shimming
Assessment criteria
The learner can: 1.1 explain the issues surrounding the accurate fitting of composites 1.2 explain the reasons for shimming 1.3 explain the implications of incorrect shimming

Range
List1 Inaccuracies in manufacturing processes Inability to machine composites **List2** Requirement for close-tolerance fits which cannot be achieved in moulding Variability in material thickness **List3** Raised stress in critical areas of structure Unwanted voids in structure Galvanic corrosion.

Learning outcome
The learner will: 2. know health and safety and environmental procedures for composite components
Assessment criteria
The learner can: 2.1 describe health and safety documentation for shimming composites 2.2 describe hazards to health caused by the use of shimming materials 2.3 describe personal protective equipment (PPE) for use when shimming composites 2.4 describe shimming materials storage requirements 2.5 describe shimming materials waste disposal procedures 2.6 describe post-work personal hygiene procedures

Range
List1 Risk assessments: COSHH, other assessments Manufacturer's safety information Work procedures **List2** Liquid shimming material and cleaners: Toxic fumes Ingestion Skin contamination Solid material: Dust Sharp edges Skin contamination Toxic fumes **List3** Goggles Face shield Nitrile gauntlet gloves Sleeve gauntlets Disposable overalls Bump cap Respiratory protection **List 4** Location: inside or outside, secure room Special cabinet Fire alarms Fire protection Environmental control: heating, ventilation, humidity **List 5**

Location of waste areas
Quarantine arrangements
Segregation of waste
Types of waste disposal bin (e.g. coding system, labelled bins)
Frequency of collection
Reporting procedures

List 6
Clean rooms
Wash Areas
Barrier creams
Special washing procedures
Emergency showers

Learning outcome
The learner will: 3. understand surface preparation techniques
Assessment criteria
The learner can: 3.1 explain reasons for preparing surfaces for shimming 3.2 describe materials and equipment used in surface preparation 3.3 describe mechanical processes for preparing surfaces 3.4 describe chemical processes for cleaning surfaces

Range
List 1 Chemical contamination Foreign objects Effects of contamination e.g: Degraded bonds Deterioration of shim material Reduced service life Safety implications **List 2** Materials: Lint-free cloths Disposable wipes Plastic scrapers/spatulas Chemicals e.g: De-greaser **List 3** Vacuum cleaning Fume and dust extraction **List 4** One-time use of chemical wipes

Application life of chemical Inspection e.g: Post-cleaning check for residual contamination e.g: dry cloth test Visual: adequate lighting, magnifier, clean cloth check

Learning outcome
The learner will: 4. know gap measurement methods
Assessment criteria
The learner can: 4.1 state reasons for accurate gap measurement prior to shimming 4.2 describe types of gap-measuring equipment and recording methods

Range
List1 Typical location of gaps Enable selection of correct shim size and method e.g. solid, liquid or both **List2** Measurement: Feeler gauges Vernier callipers Micrometer Ruler Ultrasound Recording e.g: Build records Inspection reports.

Learning outcome
The learner will: 5. understand shimming procedures
Assessment criteria
The learner can: 5.1 explain limits of gap dimensions for shim types 5.2 explain the selection of shim types and sizes 5.3 explain the use of release tape in the shimming process 5.4 describe the insertion of liquid shims 5.5 describe the insertion of solid shims 5.6 describe shim inspection procedures

Range
List 1 Gap dimension limits for the selection of shims: Solid parallel and tapered Liquid

List 2
Liquid shim used in all gaps
Additional solid shim used in excessive gaps
Reference to manufacturing documentation

List 3
Reason for use:
Release tape: prevents adhesion of shim to component to allow easy removal
Reference to manufacturing documentation

List 4
Shimming material:
Work life and cure time (e.g: effects of temperature, humidity etc)
Mix labelling (e.g: mix start/finish time, expiry time)
Mixing methods (e.g: multi-pack, cartridge, mixing nozzle)
Consistency check (e.g: visual check for colour streaks)
Application methods:
Release film
Dispensing gun (e.g: pneumatic, mechanical)
Ensure an even spread of liquid shim on surfaces
Spatula to clean excess shimming material
Safety precautions (e.g: Prevention of thermal runaway, fume extraction)

List 5
Identify shimming material specifications (e.g: part number)
Handling techniques e.g:
Care in use of tab (avoiding touching shim surfaces)
Position shim for marking off
Trimming shim to size
Record location of shim

List 6
Inspection for e.g:
Quality of cured material
Integrity of bond
Cleanliness of surfaces
Coverage and absence of voids
Overhang/undercut
Rough edges
Finished dimensions (e.g. no gaps between mating components)

Learning outcome
The learner will: 6. understand cleaning following shimming processes
Assessment criteria
The learner can: 6.1 identify cleaning equipment 6.2 describe cleaning procedures

6.3 describe inspection criteria following the cleaning process

Range
List 1 Materials and equipment e.g: Lint-free cloths Disposable wipes Vacuum cleaner Extraction system Plastic scrapers/spatulas De-greaser Solvents **List 2** Removal of: Excess shim material (eg spew) Release materials **List 3** Visual inspection for: Excess material (cosmetic and weight implications) Foreign objects

Learning outcome
The learner will: 7. be able to apply shimming procedures for composite structures
Assessment criteria
The learner can: 7.1 measure gaps between mating components 7.2 select shim types and sizes 7.3 apply cleaning and surface preparation techniques 7.4 adjust solid shims to size 7.5 assemble the components prior to shimming 7.6 apply the shimming material 7.7 monitor the curing process 7.8 apply post-application cleaning procedures 7.9 inspect the completed shim

Range
List1 Using: Feeler gauges Vernier callipers Ruler Record measurement data in e.g. Company documentation: build records, inspection reports **List2**

Reference to manufacturing documentation
Correct part numbers

List 3
Select cleaning chemicals
Use and dispose of one-time wipes
Use of lint free cloths
Inspect:
Post-cleaning check for residual contamination e.g. dry cloth test
Visual: adequate lighting, magnifier, clean cloth check

List 4
Identify shimming material specifications: part number
Use handling techniques e.g: Care in use of tab (avoiding touching shim surfaces)
Position shim for marking off
Trim shim to size
Record location of shim

List 5
Check cleanliness
Apply release materials to appropriate surface(s)
Check component part numbers
Mate the components

List 6
Liquid shim:
Shimming material:
Determine work life and cure time
Label the mix
Mix the material
Consistency check
Apply the material using e.g.
Dispensing gun

List 7
Monitor using:
Test piece
Monitoring equipment (e.g. stopwatch, temperature and humidity)

List 8
Using:
Spatula to clean excess shimming material
Cloths, wipes and solvents
Safety precautions e.g.
Fume extraction
PPE

List 9
Inspection for:

Quality of cured material Integrity of bond Cleanliness of surfaces Coverage and absence of voids Overhang/undercut Rough edges Finished dimensions (e.g. no gaps between mating components).

Unit 020 Installing fasteners in aircraft composites

UAN:	R/503/1286
Level:	3
Credit value:	4
GLH:	30
Relationship to NOS:	This unit is linked to the L2 Aeronautical Engineering Unit 25.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims give the learner knowledge and practical skills in the application of sealants and fasteners on aircraft composite materials.

Learning outcome
The learner will: 1. know the fasteners used for composite materials
Assessment criteria
The learner can: 1.1 identify types of fasteners used for assembling composite materials 1.2 describe the hole characteristics for composite fasteners 1.3 describe the advantages and disadvantages of using fasteners

Range
List1 Materials (e.g: Titanium) Fastener specifications: Hi-lock fasteners Pan head bolts Countersunk bolts Sleeved fasteners: RXL radial expanding lock bolts, RXB radial expanding bolts, Temporary fasteners: Slave bolts, Dowels, Self centring nuts and bolts, Torque controlled slave pins

Colour coding system (e.g: indicates size of fastener)

List2

Limits and fits (e.g: clearance holes, lightning strike protection)

List3

Advantages: e.g. strength, cost, reliability,

Disadvantages: e.g. weight, fuel leaks, corrosion.

Learning outcome
The learner will: 2. be able to apply sealants on composite materials
Assessment criteria
The learner can: 2.1 prepare surfaces prior to fastening composite materials 2.2 select sealants used for composite fasteners 2.3 apply sealants to composite components

Range
List1 Remove contaminants: dust, grease Cleaning and degreasing equipment: approved wipes, lint-free cloths, cleaning agents Personal protection equipment (e.g: gloves, glasses, overalls, boots, safety masks) Storage: waste bins, cosh cabinets Documentation: procedures, COSHH, risk assessments (e.g: use in confined spaces) **List2** Sealants: Interfay, aerodynamic filler/sealants, fillet sealants and gap sealants, adhesion promoters **List3** Documentation: procedures, standards, Ensuring: Sealant life, application life, shelf life, work life, tack free time and cure time, sealant labelling Equipment: spatulas, rollers, brushes, mixing systems, applicator guns

Learning outcome
The learner will: 3. be able to use manual equipment for installing fasteners
Assessment criteria
The learner can: 3.1 use production documentation 3.2 select tooling equipment used for fitting composite components

3.3 prepare fastener assembly equipment 3.4 install fasteners to components 3.5 carry out inspection of fasteners

Range
List1 Documentation: Procedures, standards, drawings, instructions, risk assessments, COSHH **List2** Tooling used for fitting: hole depth gauge, torque loading equipment (e.g. manual and automated), Allen key, **List3** Ensuring: correct equipment is selected, correct torque applicable to bolt type, condition, calibration dates, **List4** Check fasteners: part numbers, condition, correct length **List5** Fastener inspection: e.g. seating of nuts and head of fastener, correct torque applied, intrusion, protrusion, breakthrough and delamination Equipment inspection (e.g. NDT specific equipment, magnifying glass, Dial Test Indicator (DTI), feeler gauges, 'go, no-go gauges') Documentation (e.g. correct forms, inspection reports, tracking log, correct labelling).

Learning outcome
The learner will: 4. know faults associated with fastening aircraft composites
Assessment criteria
The learner can: 4.1 describe faults in assembling fastening composites 4.2 describe causes of fastening faults 4.3 state reasons for reporting defects

Range
List1 Out of tolerance: incorrect fastener, countersink (CSK) angle, CSK depth, alignment, Peripheral damage: to surrounding skin, burrs, chips, fraying, breakout damage, delamination **List2** Damaged and worn tooling, incorrect or insufficient torque loading, mishandling of material, incorrect tool and equipment selection

List3

Materials defects: operational safety, (failure of components, component unsuitable for tasks, limited visibility of the extent of damage or defect), avoiding unnecessary re-work to materials

Fastening equipment: worn and damaged tools and equipment, incorrect use of tools and equipment, faulty or incorrect use of safety equipment, misalignment

Documentation: incorrect issue, misinterpretation of documentation, incomplete documentation (e.g. no risk assessment or relevant COSHH information and procedures, documentation inaccuracies)

Unit 022 Non-destructive testing of aircraft composites

UAN:	Y/503/1287
Level:	3
Credit value:	6
GLH:	40
Relationship to NOS:	This unit is linked to the L3 Aeronautical Engineering NOS Unit 206.
Endorsement by a sector or regulatory body:	This unit is endorsed by SEMTA - the Sector Skills Council for Engineering
Aim:	This unit aims give the learner knowledge and practical skills in the in the use of non-destructive test techniques to find defects in aircraft composite materials

Learning outcome
The learner will: 1. understand defects in composite materials
Assessment criteria
The learner can: 1.1 describe types of manufacturing defects to be found in composite materials 1.2 describe types of in-service defects to be found in composite materials 1.3 describe the effects of defects on the performance of composite materials 1.4 compare the features of NDT methods

Range
List 1 Processes: Chemical contamination Thermal damage (e.g. from an overheated drill) Delamination (e.g. incorrect drill feeds, worn tooling, incorrect lay-up techniques) Matrix resin-related (e.g. incorrect mixing processes) Fibre-related Foreign object inclusions Handling and Storage: Accidental damage (e.g. mis-handling of components)

Barely Visible Impact Damage (BVID)
Impact damage (e.g. dropping components, objects falling on components)
Environmental damage (e.g. incorrect storage, manufacturing environment out of limits)

List 2
Processes
Chemical contamination (e.g. fuel, hydraulic oils)
Thermal damage (e.g. from adjacent repair, fires and overheated equipment)
Delamination
Matrix resin-related (e.g. resulting from repairs)
Fibre-related (e.g. resulting from repairs)
Foreign object inclusions (e.g. resulting from repairs)

Handling and Storage
In-service defects:
Accidental damage (e.g. miss-handling of components)
Barely Visible Impact Damage (BVID)
Impact damage (e.g. objects falling on components, ground equipment, other aircraft)
Environmental damage (e.g. moisture ingress, hailstone, lightning, erosion)

List 3
Reduced life-cycle of composite components
Safety implications
Reduced structural strength
Catastrophic failure of components

List 4
Visual
Tap test
Ultrasound
Radiography
Thermography

E.g.
Cost
Speed implement
Amount of specialist equipment required
Limitations of defect identification (e.g. surfaces only)
Reliance on human judgement.

Learning outcome
The learner will: 2. know about visual inspection of composite materials
Assessment criteria

The learner can:
2.1 describe the principle of visual inspection
2.2 describe the procedure for visual inspection
2.3 describe the classification process of results after a visual inspection

Range

List 1

First stage of inspection to detect defects:

Processes:
Chemical contamination
Delamination (e.g. incorrect drill feeds, worn tooling, incorrect lay-up techniques)
Matrix resin-related (e.g. incorrect mixing processes)
Fibre-related
Foreign object inclusions

Handling and Storage:
Accidental damage (e.g. miss-handling of components)
Barely Visible Impact Damage (BVID)
Impact damage (e.g. dropping components, objects falling on components)
Environmental damage (e.g. incorrect storage, manufacturing environment out of limits)

List 2

Prepare surface (e.g. cleaning checks)
Equipment (e.g. magnifying devices, additional lighting)
Conditions (e.g. standard workshop lighting, local inspection lighting)
Visually inspect surfaces for defects (e.g. scratches, chips, exposed fibres)
Mark each point where damage has been identified (e.g. using marking medium)
Health and safety (e.g. risk assessments of equipment, P.P.E.)

List 3

Using measuring equipment: e.g. feeler gauges, vernier callipers, micrometer, ruler
Recording documentation: Build records, Inspection reports.
Classification of defect (type, extent of the defect, in or out of specification tolerances)

Learning outcome

The learner will:
3. know about tap testing of composite materials

Assessment criteria

The learner can:
3.1 describe the principle of tap-testing
3.2 describe the procedure for tap testing

3.3 describe the classification process of results after a tap test

Range
List 1 Qualitative test to gauge the extent of defect Used for the detection and mapping of BVID Damaged and undamaged composite materials make a different sound when tapped **List 2** Prepare surface (e.g. cleaning checks) Equipment: Coin, small hammer (weight between 24gm and 36gm), automatic device (woodpecker) Tap firmly on the surface (e.g. all around and across suspect area) Listen to and interpret sounds (e.g. Sound will change in pitch and quality) Mark each point where the sound changes (including quality – good or bad) Health and safety (e.g. risk assessments of equipment, P.P.E.) **List 3** Listen to and interpret sounds (e.g. Sound will change in pitch and quality) Automatic device (e.g. print outs, saved data) Recording e.g. Classification of defect (e.g. type, extent of the defect, in or out of specification tolerances) Build records Inspection reports.

Learning outcome
The learner will: 4. know about ultrasonic inspection of composite materials
Assessment criteria
The learner can: 4.1 describe the principles of ultrasonic inspection 4.2 describe the procedure for ultrasonic inspection 4.3 describe the classification process of results after an ultrasonic inspection

Range
List 1 Qualitative test to gauge the extent of defect Used for the detection and mapping of BVID Ultrasonic techniques use sound waves of much higher pitch than can be detected by the human ear Sound wave propagate through the material **List 2**

Prepare surface (e.g. cleaning checks)

Ultrasonic NDT inspection procedures available e.g. Pulse-echo, transmission, resonance, contact, water jet, immersed (in water).

Equipment e.g. search unit, sensor head, gel, grease, oil, water.

Check equipment: Calibration dates, P.A.T testing, condition.

List 3

Interpret sound and display recorded results e.g. A-scan (depth view), B-scan (sectional view), C-scan (top view)

Recording e.g.

Classification of defect (e.g. type, extent of the defect, in or out of specification tolerances)

Build records

Inspection reports.

Learning outcome
The learner will: 5. know about Radiography inspection of composite materials
Assessment criteria
The learner can: 5.1 describe the principles of radiography inspection 5.2 describe the procedure for radiography inspection 5.3 describe the classification process of results after a radiography inspection

Range
List 1 Qualitative test to gauge the extent of defect Used for the detection and mapping of BVID Radiography uses electromagnetic radiation which can pass through solid materials. The source can be either an x-ray tube or pellet of radioactive materials emitting gamma rays. **List 2** Prepare surface (e.g. cleaning checks) Equipment: source of radiation e.g. (x-ray) films, illuminated screen, monitor screen for visual interpretation Check equipment: Calibration dates, P.A.T testing, condition Apply radiation to the material. Health and safety (e.g. risk assessments of equipment and facility, P.P.E.) **List 3** Recording e.g. Films, data bases Classification of damage (e.g. type, extent of the defect, in or out of specification tolerances) Build records Inspection reports

Learning outcome
The learner will: 6. know about thermography inspection of composite materials
Assessment criteria
The learner can: 6.1 describe the principles of thermography 6.2 describe the procedure for thermography 6.3 describe the classification process of results after a thermographic inspection

Range
List1 Qualitative test to gauge the extent of defect Used for the detection and mapping of BVID Thermography involves the detection and mapping of differences in the surface when a source of temperature by thermal radiation is applied to the composite component. **List 2** Prepare surface (e.g. cleaning checks) Equipment (e.g. heat source, thermal cameras) Check equipment: Calibration dates, PAT testing, condition Health and safety (e.g. risk assessments of equipment, PPE) **List 3** Recording e.g. Data bases Classification of defect (e.g. type, extent of the defect, in or out of specification tolerances) Build records Inspection reports

Learning outcome
The learner will: 7. understand the electrical bonding of aircraft structure
Assessment criteria
The learner can: 7.1 identify the general area of the suspected defect 7.2 select the type of tests to be applied 7.3 prepare the area of material for testing 7.4 prepare the work area and equipment for the tests 7.5 carry out tests 7.6 record the test results

Range
List 1 Classification of defect (e.g. type: in-service, production) Documentation (e.g. manuals, reports, logs)

List 2

Visual inspection
Tap testing
Ultrasonic inspection
Radiography
Thermography

List 3

Equipment: (e.g. cleaning wipes, lint free clothes
Chemicals (e.g. cleaning agents)
P.P.E (e.g. mandatory to inspection method)
Check surface is free from contaminates

List 4

Work area (e.g. inform relevant people, PPE, barriers, warning signs, lighting, cables, hoses)
Inspection equipment (e.g. part numbers, calibration date, visual inspection)

List 5

Visual inspection
Tap testing

List 6

Recording e.g.
Classification of defect (e.g. type, extent of the defect, in or out of specification tolerances)
Build records
Inspection reports

Unit 022 Non-destructive testing of aircraft composites

Supporting information

Guidance

LO4 Ultrasonic Inspection methods

Apply gel etc. to sensor head or material to be tested (the acoustic coupling between air and material is extremely poor so substances such as grease, oil, gel or water are often used as coupling materials).

Apply sensor head to area to be inspected (the sound wave is produced by vibration and transferred to the component being tested and allowed to propagate through the material). Health and safety (e.g. cosh sheets, risk assessments of equipment, PPE).

LO5 Radiation

This radiation can be absorbed by the material and thick sections absorb more radiation than thin sections or voids. After the film has been exposed it is processed using either a wet method (developed, washed, fixed, washed and dried and then placed on an illuminated screen for visual interpretation) or digital displayed on a monitor screen.

LO6 Thermogrpahy

Infra red heat is evenly applied to the inspection surface for a short period. A thermal camera will be used to record surface temperatures.

Delamination will appear as a hotter area, whilst water ingress for example will show as a cooler area.

Appendix 1 Relationships to other qualifications

Literacy, language, numeracy and ICT skills development

These qualifications can develop skills that can be used in the following qualifications:

- Functional Skills (England) – see **www.cityandguilds.com/functionalskills**
- Essential Skills (Northern Ireland) – see **www.cityandguilds.com/essentialskillsni**
- Essential Skills Wales – see **www.cityandguilds.com/esw**

Appendix 2 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 **Centres and Training Providers homepage** on **www.cityandguilds.com**.

Centre Manual - Supporting Customer Excellence contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions

Ensuring quality contains updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document contains information on:

- Management systems
- Maintaining records
- Assessment
- Internal verification and quality assurance
- External verification

Access to Assessment & Qualifications 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 homepage** section of the City & Guilds website also contains useful information such on such things as:

- **Walled Garden:** how to register and certificate candidates on line
- **Qualifications and Credit Framework (QCF)**: general guidance about the QCF and how qualifications will change, as well as information on the IT systems needed and FAQs
- **Events**: dates and information on the latest Centre events

- **Online assessment**: information on how to register for e-assessments.

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions

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Useful contacts

UK learners General qualification information	T: +44 (0)844 543 0033 E: **learnersupport@cityandguilds.com**
International learners General qualification information	T: +44 (0)844 543 0033 F: +44 (0)20 7294 2413 E: **intcg@cityandguilds.com**
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **centresupport@cityandguilds.com**
Single subject qualifications Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 F: +44 (0)20 7294 2404 (BB forms) E: **singlesubjects@cityandguilds.com**
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **intops@cityandguilds.com**
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, GOLA, Navigation, User/menu option, Problems	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **walledgarden@cityandguilds.com**
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 E: **business@cityandguilds.com**
Publications Logbooks, Centre documents, Forms, Free literature	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413

If you have a complaint, or any suggestions for improvement about any of the services that we provide, email: **feedbackandcomplaints@cityandguilds.com**

About City & Guilds

As the UK's leading vocational education organisation, City & Guilds is leading the talent revolution by inspiring people to unlock their potential and develop their skills. We offer over 500 qualifications across 28 industries through 8500 centres worldwide and award around two million certificates every year. City & Guilds is recognised and respected by employers across the world as a sign of quality and exceptional training.

City & Guilds Group

The City & Guilds Group operates from three major hubs: London (servicing Europe, the Caribbean and Americas), Johannesburg (servicing Africa), and Singapore (servicing Asia, Australia and New Zealand). The Group also includes the Institute of Leadership & Management (management and leadership qualifications), City & Guilds Land Based Services (land-based qualifications), the Centre for Skills Development (CSD works to improve the policy and practice of vocational education and training worldwide) and Learning Assistant (an online e-portfolio).

Published by City & Guilds, a registered charity established to promote education and training

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