QUALIFICATION HANDBOOK

Level 2 Diploma in Aircraft Maintenance (Civil Aircraft) (2675-02)

September 2017 Version 1.1

City & Guilds

Qualification at a glance

Subject area	Aeronautical Engineering
City & Guilds number	2675
Age group approved	16-18, 19+
Entry requirements	City & Guilds does not set a minimum requirement for entry to this qualification. The apprenticeship framework **suggests** the following: 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.
Assessment	Multiple Choice test, Short-Answer examination
Fast track	Available
Support materials	Centre handbook
Registration and certification	Consult the City & Guilds website for information

Title and level	GLH	TQT	City & Guilds number	Accreditation number
Level 2 Dip in Aircraft Maintenance (Civil Aircraft)	485	560	2675-02	600/1928/1

Version and date	Change detail	Section
1.1 September 2017	Added TQT details Deleted QCF	**Qualification at a glance and Structure** **Throughout**

Contents

1 Introduction

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

Area	Description
Who is the qualification for?	For candidates who work or want to work in the aeronautical engineering sector across a range of roles and career routes.
What does the qualification cover?	Allows candidates to learn, develop and practise the skills required for employment and/or career progression in the aeronautical engineering sector.
Is the qualification part of a framework or initiative?	This qualification is recognised as a technical certificate in the Engineering Manufacture apprenticeship framework.
What opportunities for progression are there?	Further opportunities for candidates include: • Level 2 NVQ Diploma in Aeronautical Engineering (City & Guilds 1789) • Level 3 Diploma in Aircraft Engineering (City & Guilds 2675) • Level 3 Certificate/Diploma in Aircraft Manufacturing (City & Guilds 4597) • Level 3 Diploma in Survival Equipment (City & Guilds 5412)

Structure

Learners must require a total of **56 credits** from the Mandatory Units.

Mandatory Units

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
H/503/0806	Unit 001	Fundamentals of aviation mathematics and science	5
M/503/1263	Unit 035	Human factors in aviation	5
D/503/0898	Unit 101	Fundamental of electrics and theory of flight	5
H/503/0899	Unit 102	Fundamentals of airframe construction and systems	11
M/503/1103	Unit 010	Fundamentals of aircraft gas turbine engines	13
F/503/0859	Unit 012	Fundamentals of aircraft propellers	6
L/503/0900	Unit 103	Fundamentals of aircraft electrical and avionic systems	11

Total Qualification Time

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a Learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and assessment.

Title and level	GLH	TQT
Level 2 Dip in Aircraft Maintenance (Civil Aircraft)	485	560

2 Centre requirements

Approval

For Level 2, centres already delivering the Level 2 City & Guilds Certificate in Aeronautical Engineering (2597) will be automatically approved to run the Level 2 routes in this qualification.

For Level 3, centres already delivering the City & Guilds Certificate in aeronautical Engineering (2661) will be automatically approved to run this new qualification at both levels 2 and 3.

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the *Centre Manual - Supporting Customer Excellence* for further information.

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

Resource requirements

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 area 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, eg 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 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 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 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 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 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 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 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 qualification. 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 this qualification 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 qualification
- any units they have already completed, or credit they have accumulated which is relevant to the qualification
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualification, 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**, 2675 qualification pages
Centre devised generic guidance: • Centre guidance • Generic grading criteria	**www.cityandguilds.com**, 2675 qualification pages
Guidance for producing centre devised tasks (specific guidance for each unit within a pathway)	**www.cityandguilds.com**, 2675 qualification pages
Example assignments (for selected units only)	**www.cityandguilds.com**, 2675 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
2675-001	Fundamentals of aviation mathematics and science	Online
2675-010	Fundamentals of aircraft gas turbine engines	CAA or Short-Answer
2675-012	Fundamentals of aircraft propellers	CAA or Short-Answer
2675-035	Human factors in aviation	Online
2675-101	Fundamental of electrics and theory of flight	Online
2675-102	Fundamentals of airframe construction and systems	Short-Answer
2675-103	Fundamentals of aircraft electrical and avionic systems	Short-Answer

Time constraints

Timings for e-assessments are indicated in the test specifications on page 11-14

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.

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.

Test specifications

The way the knowledge is covered by each online or short-answer test is laid out in the tables below:

Test 1: Unit 001 Fundamentals of Aviation Mathematics and Science
Duration: 70 minutes

Outcome	Number of questions	%
01 Be able to use arithmetic and algebra to solve problems	7	15
02 Be able to use simple graphs	3	6
03 Know Imperial, SI and US Customary units used in aeronautical engineering	4	9
04 Know the nature of matter	3	7
05 Know principles of Statics	8	18
06 Know principles of Kinetics	4	9
07 Know principles of Dynamics	7	16
08 Know principles of Fluid Dynamics	4	9
09 Know properties of the Earth's atmosphere.	5	11
Total	**45**	**100**

Test 2: Unit 010 Fundamentals of aircraft gas turbine engines
Duration: 60 minutes

Outcome	Number of questions	%
01 Understand the fundamental principles of aircraft gas turbine engines	4	14
02 Understand the operation of gas turbine engines	5	20
03 Understand gas turbine fuels, lubricants and associated systems	4	16

04 Understand gas turbine starting, ignition and air systems	2	8
05 Understand gas turbine engine indication systems	3	12
06 Understand auxiliary power units and power-plant installations	2	8
07 Understand gas turbine engine monitoring, fire protection and ground operation	5	20
Total	**25**	**100**

Test 3: Unit 012 Fundamentals of aircraft propellers
Duration: 60 minutes

Outcome	**Number of questions**	**%**
01 Understand propeller theory	7	33
02 Understand propeller construction	3	15
03 Understand propeller pitch control	3	15
04 Understand propeller ice and rain protection systems	2	10
05 Understand propeller maintenance, storage and preservation	5	27
Total	**20**	**100**

Test 4: Unit 035 Human Factors in Aviation
Duration: 60

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 5: Unit 101 Fundamentals of Electrics and Theory of Flight
Duration: 60 minutes

Outcome	**Number of questions**	**%**
01 Understand electrical concepts	11	27.5
02 Know about direct current power sources and machines	7	17.5
03 Know the principles of alternating current	3	7.5
04 Know about aircraft electrical devices and data transmission	4	10
05 Know the forces acting on an aircraft in flight	8	20
06 Know about aircraft stability and control	7	17.5
Total	**40**	**100**

Test 6: Unit 102 Fundamentals of airframe construction and systems
Duration: 60 minutes

Outcome	**Number of questions**	**%**
01 Know the concepts of airframe structures and components	3	15
02 Understand the operation of aircraft hydraulic power systems	3	15
03 Understand the operation of aircraft flight control systems	3	15
04 Understand the operation of aircraft landing gear systems	2	10

05 Understand the operation of aircraft ice and rain protection systems	2	10
06 Understand the operation of aircraft oxygen and air systems	5	25
07 Know aircraft interior fittings and systems	2	10
Total	**20**	**100**

Test 7: Unit 103 Fundamentals of aircraft electrical and avionic systems

Duration: 45 or 60 minutes (dependent on version of paper)

Outcome	**Number of questions**	**%**
01 Know about aircraft electrical supply systems	4	9
02 Understand aircraft electrical components and safety devices	4	10.5
03 Know about gas turbine air start and ignition systems	4	12
04 Know about aircraft electrical fuel contents indicating systems	2	5
05 Know about aircraft fire protection systems	2	5
06 Know about aircraft instrument systems	5	15
07 Know about airborne navigational aids	4	10
08 Know about aircraft communication and radar systems	7	17.5
09 Understand software management control	3	5
10 Know about automatic flight control	5	11
Total	**40**	**100**

5 Units

Availability of units

Below is a list of the learning outcomes for all the units. If you want to download a complete set of units, go to **www.cityandguilds.com**

Structure of units

These units each have the following:

- City & Guilds reference number
- unit accreditation number (UAN)
- title
- level
- credit value
- unit aim
- relationship to NOS, other qualifications and frameworks
- endorsement by a sector or other appropriate body
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance

Unit 001 Fundamentals of aviation mathematics and science

Level: 2

Credit value: 5

UAN: H/503/0806

Unit aim

The aim of this unit is to give learners a solid grounding in basic mathematics and science to enable further aeronautical engineering studies.

Learning outcomes

There are **nine** learning outcomes to this unit. The learner will:

1. be able to use arithmetic and algebra to solve problems
2. be able to use simple graphs
3. know Imperial, SI and US Customary units used in aeronautical engineering
4. know the nature of matter
5. know principles of statics
6. know principles of kinetics
7. know principles of dynamics
8. know principles of fluid dynamics
9. know properties of the Earth's atmosphere.

Guided learning hours

It is recommended that **40** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 2 NOS Units 002, 014 etc.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:

- Application of Number

Assessment and grading

This unit will be assessed by:

- A multiple –choice test covering underpinning knowledge.

Unit 001 Fundamentals of aviation mathematics and science

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

Assessment Criteria

The learner can:

1. perform arithmetical calculations using whole numbers
2. prioritise basic functions within arithmetical calculations
3. manipulate fractions and decimals to solve problems
4. manipulate ratios, proportions, averages and percentages to solve problems
5. calculate areas and volumes
6. calculate simple powers of numbers
7. manipulate simple algebraic expressions.

Range/Scope/Unit content

List 1

Add
Subtract
Multiply
Divide
Positive and negative whole numbers

List 2

Using BODMAS

List 3

Simplify and solve problems
Understand numerator, denominator
Reduce fractions
Convert between mixed numbers and improper fractions
Add, subtract, multiply, divide fractions
Define 'decimal'
Express values to given number of decimal places
Add, subtract, multiply, divide decimals
Convert between decimals and fractions
Make calculations using simple decimals and fractions

List 4

Simplify and solve problems
Explain percentages
Convert percentages to decimals and fractions and vice versa
Explain 'ratio' and 'proportion'
Make simple engineering calculations involving ratios and proportion

List 5

Importance of units

State and use formulae for areas of:

- Triangle
- Rectangle
- Circle

State and use formulae for volumes of:

- Triangular prisms
- Rectangular boxes
- Cylinders

List 6

Squares

Square roots

Cubes

Cube roots

In conjunction with areas and volumes

List 7

Simplify, change the form of and evaluate first order algebraic expressions:

- Add, subtract, multiply, divide
- Use of brackets
- Simple algebraic fractions.

Unit 001 Fundamentals of aviation mathematics and science

Outcome 2 Be able to use simple graphs

Assessment Criteria

The learner can:

1. describe the basic principles of graphical representation
2. identify graphs of simple equations and common functions
3. extract data from graphs used in aeronautical engineering.

Range/Scope/Unit content

List 1

Axes
Grid lines
Origin
Scales
Calculating key values
Plotting graphs

List 2

Eg:
$y = mx + c$
sine wave
square wave

List 3

Eg:
ICAO temp/altitude
Fuel data
Engine performance

Unit 001 Fundamentals of aviation mathematics and science

Outcome 3 Know Imperial, SI and US Customary units used in aeronautical engineering

Assessment Criteria

The learner can:

1. state base and derived SI units and representative symbols
2. state the meaning of prefixes used with SI units
3. state Imperial units and representative symbols
4. state US customary units used in aviation
5. convert between Imperial, US customary and SI units.

Range/Scope/Unit content

List 1

Explain:
Base
Derived
State base units and symbols:
Time
Length
Mass
Temperature
Current
State derived units and symbols:
Area
Volume
Density
Acceleration
Force
Pressure
Inertia
Impulse
Momentum
Torque
Energy (work)
Power
Voltage
Resistance
Frequency
Explain the relationship between Kelvin and degrees Celsius
Specific Gravity as a ratio

List 2
State meaning of prefixes and identify symbols:
Micro
Mili
Kilo
Mega
Convert between prefixes

List 3
Including US gallons and US (short) ton
Length
Mass
Velocity
Temperature (Centigrade, Kelvin, Fahrenheit)
Pressure
Volume
Torque

List 4
Convert between:
Centimetres and inches
Kilograms to pounds
Litres to gallons (Imperial and US)
US to UK gallons
Litres to kilograms
lbf to Nm.

Unit 001 Fundamentals of aviation mathematics and science

Outcome 4 Know the nature of matter

Assessment Criteria

The learner can:

1. describe the structure of atoms
2. explain concepts of chemical elements
3. explain concepts of chemical compounds
4. define the three 'classical' states of matter
5. explain how matter changes between states.

Range/Scope/Unit content

List 1

Simple explanation of:
Proton
Neutron
Electron
Nucleus
Atom

List 2

Simple explanations:
Define 'element'
How elements are different from one another
Basic element structure

List 3

Simple explanations:
Define compound, mixture
Chemical bonds
Explain 'molecule'

List 4

Solid
Liquid
Gas

List 5

Eg:
Constant temperature
Volume changes (especially expansion of water when frozen)
Physical behaviour of molecules
Latent heat.

Unit 001 Fundamentals of aviation mathematics and science

Outcome 5 Know principles of Statics

Assessment Criteria

The learner can:

1. explain forces, moments and couples
2. make simple calculations involving forces, moments and couples
3. explain equilibrium and centre of gravity
4. make calculations involving equilibrium and centre of gravity
5. explain stress, strain and elasticity, compression, shear and torsion
6. describe properties of solids, liquids and gases
7. explain pressure and buoyancy in liquids
8. solve problems involving pressure in liquids.

Range/Scope/Unit content

List 1

Define:

- Force
- Moment
- Couple
- Vector

How forces, moments and couples can be represented as vectors using simple diagrams

List 2

Using SI units only

Force

Perpendicular distance

Simple calculations for: force, moments, couples

List 3

Using two forces

List 4

Simple calculations involving two forces

List 5

Define and explain the basics of: stress, strain, elasticity, compression, shear, torsion

List 6

Basic properties eg:

Shape, viscosity, volume, compressibility

List 7
Define:
Buoyancy
Explain the relationship between density, mass and volume
Specific gravity
Explain how barometers work
Upward thrust on a body in a fluid

List 8
Including measurement of pressure using a simple barometer
Pressure at depth in a fluid.

Unit 001 Fundamentals of aviation mathematics and science

Outcome 6 Know principles of Kinetics

Assessment Criteria

The learner can:

1. explain basic principles of linear motion
2. explain basic principles of rotational movement
3. explain basic principles of periodic motion
4. explain properties of simple mechanical systems.

Range/Scope/Unit content

List 1

Explain and use basic principles:
Uniform motion in a straight line
Velocity
Momentum
Linear motion under constant acceleration (eg: gravity)
Make simple calculations involving linear motion

List 2

Explain and use basic principles:
Uniform circular movement
Centrifugal/centripetal forces
Make simple calculations involving rotational motion

List 3

Explain and use basic principles:
Define pendular movement
Simple theory of:

- Vibration
- Harmonics
- Resonance

List 4

Explain and use basic principles:
Define:

- Velocity ratio
- Mechanical advantage
- Efficiency

Make simple calculations involving simple mechanical systems.

Unit 001 Fundamentals of aviation mathematics and science

Outcome 7 Know principles of dynamics

Assessment Criteria

The learner can:

1. explain principles of dynamics involving mass, force and inertia
2. explain principles of dynamics involving energy, work and power
3. explain principles of dynamics involving heat
4. explain principles of dynamics involving efficiency
5. explain principles of dynamics involving momentum and impulse
6. explain gyroscopic principles
7. explain basic principles of dynamics involving friction.

Range/Scope/Unit content

List 1

Explain and use the basic principles:

Units

Make simple calculations for mass and force only

List 2

Explain and use the basic principles:

- Units
- Conduction
- Radiation

List 3

Explain and use the basic principles:

List 4

Explain and use the basic principles:

List 5

Explain and use the basic principles:

- Units
- Make simple calculations involving momentum

List 6

Explain:

- The purpose of a gyroscope
- Application in aircraft
- Component parts of a basic gyroscope: spinning mass, gimbals etc
- Precession

- Safety precautions for working with gyroscopic equipment

List 7
Basic principles
Units
Make simple calculations
Static Friction
Dynamic Friction
Co-efficient of Friction

Unit 001 Fundamentals of aviation mathematics and science

Outcome 8 Know principles of fluid dynamics

Assessment Criteria

The learner can:

1. make calculations using the specific gravity and density of a fluid
2. explain principles of viscosity, fluid resistance and the effects of streamlining
3. explain principles and effects of compressibility in a fluid
4. explain principles of types of fluid pressure
5. explain the principles of a venturi.

Range/Scope/Unit content

List 1

Explain basic principles

Units/lack of units

Simple calculations involving aircraft fuel and other fluids

List 2

Explain basic principles

Units

List 3

Explain basic principles

Units

Include qualitative effects of contaminants such as water in hydraulic oil

List 4

Explain basic principles of:

- Static
- Dynamic
- Total
- Units

List 5

Basic principles

Including an explanation of the simplified form of Bernoulli's Theorem

Unit 001 Fundamentals of aviation mathematics and science

Outcome 9 Know properties of the Earth's atmosphere

Assessment Criteria

The learner can:

1. describe the relationship between the three main temperature scales
2. define the term 'heat' and how it relates to temperature
3. describe the composition and structure of the Earth's atmosphere
4. explain how pressure, density and temperature vary with altitude
5. explain pressure terms
6. explain the need for a Standard Atmosphere.

Range/Scope/Unit content

List 1

Fahrenheit
Centigrade
Kelvin
Absolute zero

List 2

Using simple illustrations

List 3

Percentages of gases
Layers of the atmosphere

List 4

Including the effects at the Tropopause
ISA graphs

List 5

Explain and illustrate their relationship using simple examples
Atmospheric pressure
Absolute pressure
Differential pressure

List 6

Eg:
Standard measurements, particularly of altitude
Standardisation of instruments/displays
Engine performance.

Unit 001 Fundamentals of aviation mathematics and science

Notes for guidance

This unit contains the complete syllabus of the European Aviation Safety Agency EASA 2042/2003 part 66 Basic Knowledge Requirements ('Part 66') Module 1 – Maths and Module 2 - Science for category 'A' licences. 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 1
Outcome 2: EASA Level 1
Outcome 3: EASA Level 1
Outcome 4: EASA Level 1
Outcome 5: EASA Level 1
Outcome 6: EASA Level 1
Outcome 7: EASA Level 1
Outcome 8: EASA Level 1 (except 9.1 – EASA Level 2)
Outcome 9: EASA Level 1

Note 1: the above list equates to the EASA requirement for category 'A' licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Note 2: Both UK and US Imperial units should be taught because they are both in regular use in the aviation industry and their misuse has severe safety implications.

Unit 010 Fundamentals of aircraft gas turbine engines

Level: **2**
Credit value: **13**
UAN: **M/503/1103**

Unit aim

This unit aims to provide learners with a basic understanding of aircraft gas turbine engines and their associated systems. It covers the complete syllabus for EASA Part-66 Module 15 for Category A licenses.

Learning outcomes

There are **seven** learning outcomes to this unit. The learner will:

1. understand the fundamental principles of aircraft gas turbine engines
2. understand the operation of gas turbine engines
3. understand gas turbine fuels, lubricants and associated systems
4. understand gas turbine starting, ignition and air systems
5. understand gas turbine engine indication systems
6. understand auxiliary power units and power-plant installations
7. understand gas turbine engine monitoring, fire protection and ground operation.

Guided learning hours

It is recommended that **115** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Level 2 Aeronautical Engineering NOS Unit 7

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:

- Application of Number
- Communication
- Improving Own Learning and Performance

Assessment and grading

This unit will be assessed by:

- An internally marked short answer question paper covering underpinning knowledge.

Unit 010 Fundamentals of aircraft gas turbine engines

Outcome 1 Understand the fundamental principles of aircraft gas turbine engines

Assessment Criteria

The learner can:

1. explain the need for gas turbine propulsion
2. describe how the laws of motion and energy apply to the operation of gas turbine engines
3. describe shaped ducts
4. describe the constructional arrangement of turbojet, turbofan, turboshaft and turbo-prop engines.

Range/Scope/Unit content

List 1

In simple terms:

Limitations of a piston engine

Requirement to fly high and fast

Fuel economy

Power

List 2

In simple terms:

Newton's Third Law of Motion

Force

Work

Power

Energy

Acceleration

List 3

In simple terms:

- Inlet
- Convergent and divergent ducts

Intake design eg:

Pod, side, bifurcated, wing root, bellmouth, variable geometry, chin intake, S- duct

The effect shaped ducts have on gas flows

Velocity

Temperature

Acceleration

Intake anti-icing

List 4

In simple terms:
Compressor
Combustion
Turbine
Exhaust
Engine spools
Gearboxes including output drives
Propellers and rotors.

Unit 010 Fundamentals of aircraft gas turbine engines

Outcome 2 Understand the operation of gas turbine engines

Assessment Criteria

The learner can:

1. describe the operation of a compressor section
2. describe the operation of a combustion section
3. describe the operation of a turbine section
4. describe the operation of an exhaust section
5. describe the operation of the main gas turbine engine types.

Range/Scope/Unit content

List 1

In simple terms:
Purpose
Axial flow compressor
Centrifugal compressor
Single, twin and multi spool compressors
Rotors
Stators
Airflow

List 2

In simple terms:
Purpose
Typical materials
Combustion chambers
Air/fuel ratio

List 3

In simple terms:
Purpose
Materials
LP and HP turbines

List 4

In simple terms:
Purpose
Jet pipe/exhaust unit/propelling nozzle
Noise suppression
Reverse thrust
Thrust augmentation

List 5

In simple terms:
Turbojet
Turbo-prop
Turbo-shaft
Bypass (fan) engine
Torque producing engines
Thrust producing engines
Simple explanation of engine rating and factors affecting performance

Unit 010 Fundamentals of aircraft gas turbine engines

Outcome 3 Understand gas turbine fuels, lubricants and associated systems

Assessment Criteria

The learner can:

1. describe the properties and specifications required for gas turbine fuels and lubricants
2. describe safety precautions applicable to gas turbine fuels and lubricants
3. describe gas turbine lubrication systems
4. describe gas turbine fuel systems.

Range/Scope/Unit content

List 1

In simple terms:
Specification
Viscosity
Calorific value
Synthetic oils
Additives eg anti icing

List 2

Fire
Contamination
Specification
Water sediment
Bacterial growth

List 3

In simple terms:
Purpose
Loss and re-circulatory systems
Engine oil level checks
Pumps
Filters
Replenishment documentation

List 4

In simple terms:
Purpose
Safety issues
Fuel tanks

Fuel pumps
Main and emergency switches
Filters
Refuelling
Defuelling
Fuel jettison
Fuel contents
Engine control and fuel metering (eg: FADEC).

Unit 010 Fundamentals of aircraft gas turbine engines

Outcome 4 Understand gas turbine starting, ignition and air systems

Assessment Criteria

The learner can:

1. describe the operation of a gas turbine starting system
2. describe the operation of a gas turbine ignition system
3. describe the operation of a gas turbine air system.

Range/Scope/Unit content

List 1

In simple terms:

Purpose

Types of starting systems eg: electric, air, gas turbine, hydraulic, cartridge

List 2

In simple terms:

Purpose

Typical ignition system components eg: high energy ignition units, igniter plug

Safety precautions

List 3

In simple terms:

Purpose

Anti icing

Internal cooling

External air services.

Unit 010 Fundamentals of aircraft gas turbine engines

Outcome 5 Understand gas turbine engine indication systems

Assessment Criteria

The learner can:

1. describe gas turbine exhaust/turbine temperature indications/indicators
2. describe gas turbine oil pressure/temperature indications/indicators
3. describe gas turbine fuel pressure/flow indications/indicators
4. describe gas turbine engine speed indications/indicators
5. describe gas turbine vibration measurement and indication
6. describe gas turbine engine thrust/torque/power indications/indicators.

Range/Scope/Unit content

List 1

In simple terms:
Gauges
Thermocouples
Warning panel/attention getters

List 2

In simple terms:
Temperature sensitive transmitter
Temperature indicator
Pressure switches/ transducers
Pressure gauge/indicator
Warning panel/attention getters

List 3

In simple terms:
Pressure switches/transducers
Pressure indicators/gauges
Fuel flow transmitters
Flow indicator
Warning panel/attention getters

List 4

In simple terms:
Engine speed indicator
Engine speed generator

List 5
In simple terms:
Vibration transmitter
Warning indicator

List 6
In simple terms:
Engine pressure transmitter
Engine pressure ratio
Engine turbine discharge pressure/jet pipe pressure systems
Torque transmitter
Torque indicator.

Unit 010 Fundamentals of aircraft gas turbine engines

Outcome 6 Understand auxiliary power units and power-plant installations

Assessment Criteria

The learner can:

1. describe the operation of a typical auxiliary power unit
2. describe a typical power plant installation.

Range/Scope/Unit content

List 1

In simple terms:
Purpose
Operation including safety monitoring
Protection systems

List 2

In simple terms eg:
Intakes
Exhaust and jet pipe
Firewalls
Cowlings
Acoustic panels
Engine mounts
Anti-vibration mounts
Accessories
Hoses
Pipes
Connectors
Wiring looms
Control cables and rods
Lifting and slinging points
Drains.

Unit 010 Fundamentals of aircraft gas turbine engines

Outcome 7 Understand gas turbine engine monitoring, fire protection and ground operation

Assessment Criteria

The learner can:

1. describe the operation of fire detection and extinguishing systems
2. describe the procedure for starting and engine ground run-up
3. describe engine monitoring systems
4. describe compressor washing
5. describe foreign object damage (FOD).

Range/Scope/Unit content

List 1

In simple terms:
Prevention of engine fire ignition
Engine cooling and ventilation
Fire detectors
Fire warning
Attention getters
Fire extinguishers and discharge nozzles

List 2

In simple terms:
Fire precautions
Performance checks
Mechanical integrity
Noise suppression
Safe running zones
Personal protective equipment

List 3

In simple terms:
Scheduled maintenance
Unscheduled maintenance
Oil sampling
Condition monitoring
Purpose
Equipment
Periodicity

List 4

In simple terms:
Reasons for washing compressors
Precautions when washing eg: blanking off electrics and air ducts to prevent ingress
Washing methods using water or detergent
Describe a typical compressor wash rig

List 5

Causes of foreign object damage eg:
Loose articles in or on the aircraft eg: loose panels, lost fasteners
Loose articles on taxiways, ramps etc
Types of foreign object damage to engines eg:
Impact damage to inlet components,
Damage by small, hard objects to compressor and turbine blades
Ways of preventing FOD eg
Strict cleaning and inspection of aircraft both inside and out
Following maintenance procedures and practices
Aircraft Runway and taxiway cleaning.

Unit 010 Fundamentals of aircraft gas turbine engines

Notes for guidance

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 15 – Gas Turbine Engine. 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 1 (except 3. – EASA Level 2)
Outcome 2: EASA Level 1 (except 3. – EASA Level 2)
Outcome 3: EASA Level 1
Outcome 4: EASA Level 1
Outcome 5: EASA Level 1
Outcome 6: EASA Level 1
Outcome 7: EASA Level 1
Outcome 8: EASA Level 1
Outcome 9: EASA Level 1

Note: the above list equates to the EASA requirement for category A1 and A3 licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 012 Fundamentals of aircraft propellers

Level: 3

Credit value: 6

UAN: F/503/0859

Unit aim

This unit aims to provide learners with a detailed understanding of aircraft propellers, and associated systems. It contains the complete syllabus for EASA Part-66 Module 17 for A1 and A2 Categories.

Learning outcomes

There are **five** learning outcomes to this unit. The learner will:

1. understand propeller theory
2. understand propeller construction
3. understand propeller pitch control
4. understand propeller ice and rain protection systems
5. understand propeller maintenance, storage and preservation.

Guided learning hours

It is recommended that **50** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 3 NOS Units 143, 331 etc.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA

Key Skills

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:

- Application of Number
- Communication
- Improving Own Learning and Performance

Assessment and grading

This unit will be assessed by:

- A written examination covering underpinning knowledge.

Unit 012 Fundamentals of aircraft propellers

Outcome 1 Understand propeller theory

Assessment Criteria

The learner can:

1. explain blade element theory
2. explain the effects of varying blade angles, angle of attack and rotational speed
3. explain propeller slip
4. explain the aerodynamic, centrifugal and thrust forces on a propeller
5. explain the torque effect of a propeller
6. explain the effect of relative airflow on a blade's angle of attack
7. explain vibration and resonance produced by a propeller.

Range/Scope/Unit content

List 1

In simple terms:

General configuration: fixed and variable pitch

Parts of the propeller, features of the blades

Division of the blades into an infinite number of thin elements used to calculate total forces on the blade

List 2

In simple terms

Coarse and fine pitch

Combinations of rotational speed, blade angle and angle of attack in different phases of flight

Reasons for each combination

List 3

Define: geometric pitch and effective pitch

Calculate propeller slip (geometric pitch – effective pitch)

List 4

In simple terms qualitative description using simple diagrams

List 5

Qualitative explanation

List 6

Qualitative explanation

List 7

Qualitative explanation.

Unit 012 Fundamentals of aircraft propellers

Outcome 2 Understand propeller construction

Assessment Criteria

The learner can:

1. describe materials and construction methods for propellers
2. explain basic propeller terminology
3. describe the construction of different types of propeller
4. describe how propellers and spinners are installed.

Range/Scope/Unit content

List 1

Overview of typical:

Materials for composite, wood and metal blades

Composite, laminated, single piece

List 2

Overview of eg: blade station, blade face, blade shank and hub assembly, cuffs, fixed pitch, reverse-pitch, feathering, tractor, pusher, tipping and shielding

List 3

In simple terms an overview of fixed and controllable pitch and constant speed propellers

List 4

In simple terms an overview of typical installations eg:

Techniques used to ensure correct fitment

Types of bolts and locking devices

Alignment

Measuring and testing.

Unit 012 Fundamentals of aircraft propellers

Outcome 3 Understand propeller pitch control

Assessment Criteria

The learner can:

1. describe propeller speed control and pitch change methods
2. describe feathering and reverse pitch
3. explain how overspeed protection is achieved.

Range/Scope/Unit content

List 1

In simple terms an overview of eg: flyweight governor, counterweight and piston, alpha and beta ranges, engine oil pressure, HP pump for metered pressure, electronic control, propeller control unit (PCU), pitch lock

Differences between typical piston engine and turbine engine systems

List 2

Reasons for feathering and reverse pitch controls

Overview of:

Methods of achieving necessary blade angles for each (eg: engine oil, feather pump)

Mechanism for unfeathering

Other methods

List 3

Overview of eg: overspeed governor, springs, flyweights.

Unit 012 Fundamentals of aircraft propellers

Outcome 4 Understand propeller ice and rain protection systems

Assessment Criteria

The learner can:

1. describe fluid de-icing equipment for propellers
2. describe electrical de-icing equipment for propellers.

Range/Scope/Unit content

List 1

In simple terms typical systems eg:
Fluid storage
Control
Ducting
Pumps

List 2

In simple terms typical systems eg:
Sensors
Switches
Cabling and connectors
Other controls.

Unit 012 Fundamentals of aircraft propellers

Outcome 5 Understand propeller maintenance, storage and preservation

Assessment Criteria

The learner can:

1. describe propeller static and dynamic balancing
2. describe propeller blade tracking
3. describe how damage to propeller blades is assessed
4. describe propeller treatment and repair schemes
5. describe basic procedures for propeller engine running
6. describe how propellers are typically stored and preserved.

Range/Scope/Unit content

List 1

In simple terms overview of:
Causes of propeller imbalance
Balance limits
Effects of an out-of-balance propeller
Balancing equipment
Balancing methods
Relative accuracy of static and dynamic balancing

List 2

In simple terms overview of:
Causes of out-of-track propeller blades
Effects of an out-of-track propeller blade
Methods of measuring tracking
Tracking limits
Repair and adjustment

List 3

In simple terms overview of:
Erosion, corrosion, delamination, impact damage
Visual inspection, x-ray, ultrasound, other methods
Limits

List 4

In simple terms overview of:
Types of damage that can and cannot be repaired
Typical repair and treatment schemes for each type of propeller construction eg: wood, composite, metal, and each area of the propeller
Limits for repairs

Post-repair measurements and actions such as balancing, tracking, tip clearance

Recording of repairs

List 5

Including: safety, authorisations

Engine and propeller limits for ground running: power, condition, RPM

List 6

In simple terms overview of:

Methods of cleaning

Mounting to prevent distortion

Preservative coatings

Protective coverings – humidity and temperature-controlled bags and containers

Recovery from storage and preservation eg: cleaning, lubrication, inspection (visual, NDT), checking modification states.

Unit 012 Fundamentals of aircraft propellers

Notes for 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 syllabi of EASA 2042/2003 part 66 Basic Knowledge Requirements Module17 – Propeller. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the A1 and A2 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 1
Outcome 2: EASA Level 1
Outcome 3: EASA Level 1
Outcome 4: EASA Level 1
Outcome 5: EASA Level 1

Note: the above list equates to the EASA requirement for category A1 and A2 licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 035 Human factors in aviation

Level: **3**

Credit value: **5**

UAN: **M/503/1263**

Unit 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 outcomes

There are **ten** learning outcomes to this unit. The learner will:

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

Guided learning hours

It is recommended that **40** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 2 NOS Unit 001 and Level 3 NOS Unit 003.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Complete the **Key Skills** section **only** if the unit's outcomes have actually been signposted to one or more key skills qualifications, otherwise remove. Remove any key skills that aren't relevant.

Key Skills

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:

- Communication
- Improving Own Learning and Performance
- Problem Solving
- Working with Others

Assessment and grading

This unit will be assessed by:

- An online multiple-choice test.

Unit 035 Human factors in aviation

Outcome 1 Understand why human factors are important in aviation

Assessment Criteria

The learner can:

1. explain the term 'Human Factors'
2. explain why Human Factors are important in the aeronautical engineering workplace
3. explain categories of Human Factor that are important to aeronautical engineering staff.

Range/Scope/Unit content

List 1

Meaning of the term and how it is used in aviation
SHEL Model, 'Murphy's Law', anthropometry

List 2

Eg:
Safety of employees, passengers, people on the ground etc
Safety of assets (eg: aircraft, equipment etc)
Long-term health of employees
Efficiency of the organisation

List 3

Eg:
Working environment
Work patterns
Social habits
Work load
Communication
Employee health.

Unit 035 Human factors in aviation

Outcome 2 Understand features and limitations of human performance

Assessment Criteria

The learner can:

1. explain how images are seen and interpreted by humans
2. explain how sounds are heard and interpreted by humans
3. explain limitations of human memory
4. describe factors that affect mental attention span
5. describe how variations in an individual's sight and hearing can affect their behaviour
6. explain how working in challenging environments presents risks to airworthiness.

Range/Scope/Unit content

List 1

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

List 2:

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

List 3

Simple explanation eg:
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)

List 4
Eg:
Overconfidence
Boredom
Fatigue
Complexity of information
Artificial stimulants/depressants

List 5
Individually and in combination (such as in older people)
Sight eg:
Long and short sight
Optical illusion including the strobe effect
Persistence
Moving from light area to work in the dark
Optimum lighting for typical tasks
Long and short sight
Use of spectacles and magnifiers
Hearing eg:
High and low tone deafness
Tinnitus
Hearing damage, poor communication
Social isolation (at work and at home)

List 6
At height and in confined spaces eg:
Claustrophobia
Fear of heights
Limited access/egress to a large space
Confined space
Specific tasks (eg: inspections on fuselage crown or in equipment bays)
Low concentration
Rushing the task
Cutting corners
Poor vision.

Unit 035 Human factors in aviation

Outcome 3 Understand aspects of social psychology

Assessment Criteria

The learner can:

1. explain areas of individual and group responsibility in aircraft engineering environments
2. explain motivation and de-motivation
3. explain 'peer pressure'
4. explain company culture
5. explain the concepts of team working
6. identify the primary responsibilities of engineering managers and supervisors
7. discuss the basic concept of leadership.

Range/Scope/Unit content

List 1

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 (eg: rivalry, polarisation, 'social loafing')

List 2

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 eg:

- Management decisions
- Personal situation

List 3

Eg:

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

List 4

Overview of different types of culture (eg: safety, organisational, shift, team, social etc.)

More detailed knowledge of safety culture and the individual

How company culture can compromise best working practices

List 5

What is a team?

Advantages and disadvantages of team working

Team identity

Working with other teams

Ownership of tasks

Communication

Co-operation

Mutual support

List 6

Difference between management and supervisor roles

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

Engineering organisations (eg: part145, military maintenance organisation)

List 7

What is a leader?

The basic characteristics of a leader

How and when any individual might provide leadership eg:

Passing on knowledge and experience to colleagues

Organising and directing group tasks

Inspection and reporting on the work of others.

Unit 035 Human factors in aviation

Outcome 4 Understand personal factors that affect human performance

Assessment Criteria

The learner can:

1. explain effects of personal health and fitness on work performance
2. identify types of stress
3. explain effects of setting time deadlines on individual work performance
4. explain the concept of work overload and underload
5. explain the effects of shift work on sleep and fatigue
6. explain the effects of alcohol, medication and substance abuse
7. explain the personal legal obligations of individuals in the aviation industry.

Range/Scope/Unit content

List 1

Legal requirement for individual physical and mental fitness while at work

Types of medical condition that might affect work eg:

Minor illness (eg: cold, 'flu, sickness etc.)

Major physical illness (eg: heart attack, stroke, cancer etc.)

Mental illness (eg: depression etc.)

Minor physical injury (eg: sprained wrist, pulled muscle, cramp etc.)

Major physical injury (eg: broken bones, lacerations etc.)

Effects of toxins and other substances (eg: carbon monoxide, alcohol, drugs etc.)

Gradual deterioration in physical condition

List 2

Define 'stress' (eustress, distress, acute stress, chronic stress, hypo stress, hyper stress)

Sources:

- Home (eg: family illness, divorce etc.)
- Work (organisational, task related)

Types:

- Acute and chronic stress
- Signs of stress (physical, health, behaviour, cognitive, other)

Explain how stress can affect individual performance at work

List 3

Actual, perceived and self-imposed deadlines

Effects of time pressure and deadlines

Managing time pressure and deadlines

List 4
Definition of work overload and underload
Results of work overload and underload
Factors determining workload
Workload management

List 5
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

List 6
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

List 7
Eg:
Alcohol limits and legal requirements for aircraft engineers
CAP 562/AN47
Transport legislation/AN45
Health and Safety legislation.

Unit 035 Human factors in aviation

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

Assessment Criteria

The learner can:

1. explain effects of noise on individuals and groups
2. explain effects of fumes on individual performance
3. explain effects of varying illumination on an individual performance
4. explain effects of variations in climate on an individual performance
5. explain effects of exposure to constant motion and vibration while working
6. explain effects of layout of a working environment on individual performance.

Range/Scope/Unit content

List 1

Eg effects on:
Concentration
Communication

List 2

Eg effects on:
Concentration
Communication
Longer term effects
Safe oxygen levels

List 3

Eg:
Ability to see detail
Moving between areas of different illumination, including well-lit hangar and night flight line
Strobe effect and propellers

List 4

Eg:
Cold/wet, warm/dry, hot/humid environments

List 5

Eg:
Working at height on scissor platforms and cherry picker
Unsteady platforms
Use of rotating or percussive tools

Vibration White Finger (VWF)

List 6
Eg:
The three components of a working environment
Layout
Cleanliness
Ease of movement between work areas
Lighting, noise, atmosphere, temperature etc
Social environment
Tasks, tools and information.

Unit 035 Human factors in aviation

Outcome 6 Understand how categories of tasks can affect human performance

Assessment Criteria

The learner can:

1. explain the importance of planning the execution of a task
2. explain effects of physically demanding work on individual performance
3. explain effects of repetitive tasks on individual performance
4. explain aspects of visual inspection
5. explain aspects of working on complex systems.

Range/Scope/Unit content

List 1

Eg:
Defining the task
Defining the resources
Personal skills and proficiency
Information

List 2

Eg:
Health and physical condition, effects of ageing
Work environment
Physical effort
Effects of ageing

List 3

Eg:
Ignoring manuals, job cards etc.
Complacency
Making assumptions

List 4

Eg:
Importance of good eyesight
Knowledge of the inspection area
Illumination
Concentration
Systematic search

List 5

Eg:

Simple system: transparent to the engineer

Complex system: opaque to the engineer

Clear understanding of the purpose of the system

System-specific training

Pooling of knowledge and skills

Clear and comprehensive information and guidance.

Unit 035 Human factors in aviation

Outcome 7 Understand communication in the workplace

Assessment Criteria

The learner can:

1. explain the importance of good communication in the workplace
2. explain the importance of accurate work logging
3. explain modes of communication between individuals and teams
4. explain the importance of maintaining individual professional currency
5. explain the importance of information dissemination.

Range/Scope/Unit content

List 1

Within and between groups eg:
Prevention of accidents
Maintaining good working relations
Organisational efficiency

List 2

Eg:
Formal work logging
Shift logging
Shift handover
Task staging
Duplicate
Inspection
Stage sheets/check

List 3

Eg:
Verbal
Written
Body language
Workplace social culture
Communication between all levels of an organisation

List 4

Eg:
Refresher training
Reading briefing material
Notices and amendments to maintenance procedures
Reading professional journals
Undertaking up-skilling and further licence training.

Unit 035 Human factors in aviation

Outcome 8 Understand the causes of human error

Assessment Criteria

The learner can:

1. explain the error models and theories used in aeronautical engineering
2. explain types of error that occur during work on aircraft
3. describe the error-incident-accident chain
4. describe methods of managing and avoiding errors.

Range/Scope/Unit content

List 1

Eg

Induced

Variable

Reversible/irreversible

Slips, lapses and mistakes

The 'Swiss Cheese Model'

List 2

Eg:

Complacency

Environmental capture

Rule-based errors

Violations

Individual practices and habits

Errors associated with visual inspection

Latent/active errors

List 3

Eg:

Self discipline

Safety Management System

Anonymous and blame-free reporting

Training

Logging and analysis.

Unit 035 Human factors in aviation

Outcome 9 Understand the human factors aspects of aircraft incidents

Assessment Criteria

The learner can:

1. analyse an incident report to extract information
2. identify a sequence of events from a narrative report
3. identify human factors contributing to an incident
4. draw conclusions from incident data.

Range/Scope/Unit content

List 1

Using extracts from an actual report or a realistic example
Filter out irrelevant detail

List 2

How, why, when where, who
Use presentation aids such as flow diagrams
Identify what should have been done

List 3

Analyse the information and identify contributing factors
Including where possible:

- Personal behaviour
- Environmental conditions
- Management
- Organisational culture

Using eg:

- MEDA
- MEMS

List 4

Including where necessary, brief details of:
Environment
Personal issues
Organisation
Nature and mix of allocated tasks
Recommendations for preventative action.

Unit 035 Human factors in aviation

Outcome 10 Understand risk assessments in aeronautical engineering environments

Assessment Criteria

The learner can:

1. define the terms associated with risk assessment
2. describe the five steps to risk assessment
3. describe the associated risks for workplace hazards
4. describe conclusions from risk assessments
5. explain how to manage workplace emergencies.

Range/Scope/Unit content

List 1

Hazard

Risk

Severity

Likelihood (probability)

List 2

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

List 3

Step 2

List 4

Steps 2 and 3

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

List 5

Steps 3 and 4 eg:

Reduce the likelihood of them happening

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

Unit 035 Human factors in aviation

Notes for 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 101 Fundamentals of electrics and theory of flight

Level: **2**

Credit value: **5**

UAN: **D/503/0898**

Unit aim

The aim of this unit is to give learners a solid grounding in basic electrical theory and aerodynamics to enable further aeronautical engineering studies.

Learning outcomes

There are **six** learning outcomes to this unit. The learner will:

1. understand electrical concepts
2. know about direct current power sources and machines
3. know the principles of alternating current
4. know about aircraft electrical devices and data transmission
5. know the forces acting on an aircraft in flight
6. know about aircraft stability and control.

Guided learning hours

It is recommended that **40** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 2 NOS Units 7 and 8.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:

- Application of Number

Assessment and grading

This unit will be assessed by:

- An online multiple-choice test.

Unit 101 Fundamentals of electrics and theory of flight

Outcome 1 Understand electrical concepts

Assessment Criteria

The learner can:

1. explain the difference between a conductor and an insulator
2. explain static electricity and conduction
3. explain the build-up of static charge on an aircraft surface
4. explain electrical terms
5. perform calculations involving Ohm's Law
6. identify series, parallel and series-parallel circuits
7. calculate current division through series and parallel stages in a network
8. calculate voltage drop across series and parallel stages in a network
9. describe ways in which electricity can be produced
10. explain the purpose of a capacitor
11. describe the construction of a capacitor
12. explain the operation of a capacitor.

Range/Scope/Unit content

List 1

Basic electron theory:

Structure and distribution of electrical charges within atoms, molecules, ions and compounds

Molecular structure of conductors, semi-conductors and insulators

List 2

Basic explanation of:

Static electricity and distribution of electrical charges

Electrostatic laws of attraction and repulsion

Units of charge

Coulomb's Law

Conduction of electricity in solids, liquids and gases, and in a vacuum

List 3

Basic explanation of static build-up

Describe how to prevent static build-up eg:

Conductive tyres

Static wick dischargers

List 4
Basic explanation of:
Potential Difference
Electromotive force
Voltage
Current
Resistance
Conductance
Charge
Conventional current flow
Electron flow

List 5
Basic explanation of:
Light
Heat
Friction
Pressure
Chemical action
Magnetism
Motion

List 6
Visual identification
Simple calculations for resistance

List 7
DC circuits with varying resistances in combinations

List 8
Explain in simple terms and do calculations:
Eg: basic Kirchoff calculations

List 9
In simple terms:
Heat
Light
Friction
Pressure
Chemical action
Magnetism
Motion

List 10
Charge storage
Smoothing
Emergency Power
DC block
Resonant circuits

List 11
Construction of different types of capacitor
Role played by:
Conductors
Dielectric
Permittivity
Area

List 12
Charge/discharge cycle
Relationship between Q, C & V
Time constant.

Unit 101 Fundamentals of electrics and theory of flight

Outcome 2 Know about direct current power sources and machines

Assessment Criteria

The learner can:

1. describe the chemical action of primary and secondary cells
2. explain the connection of cells are connected in series and in parallel
3. explain the internal resistance of a battery
4. explain properties of magnetic materials
5. describe the magnetic field of a bar magnet
6. describe differences in the magnetic characteristics of soft and hard iron
7. describe uses of magnetic materials
8. describe the interaction of a current-carrying conductors and magnetic fields
9. explain the production of an EMF by the interaction of a permanent magnet with a coil
10. identify the key components of dc generators
11. identify the key components of dc motors.

Range/Scope/Unit content

List 1

Construction and basic chemical action
Dry cells
Lead acid cells
Nickel-Cadmium cells
Other alkaline cells

List 2

How and why eg: greater voltage, greater power etc

List 3

Basic explanation of internal resistance
Effect on battery performance

List 4

Eg:
Hard
Soft

List 5
Using sketches:
Flux lines
Direction
Density

List 6
Basic differences:
Hysteresis loop
Remanence
Coercive field
Relative Permeability
Demagnetisation quadrant

List 7
Common uses of:
Permanent magnets
Magnetic shielding
Electromagnet formers

List 8
In simple terms for a single conductor and one field:
Direction of current and effect on field direction
Strength of current and effect on field strength

List 9
Define electromagnetic induction
Effect of:

- number of coils
- relative speed and direction of movement

List 10
Including the arrangement of eg:
Armature
Magnets
Commutator
Brushes

List 11
Including the arrangement of eg:
Armature
Magnets
Commutator
Brushes.

Unit 101 Fundamentals of electrics and theory of flight

Outcome 3 Know the principles of alternating current

Assessment Criteria

The learner can:

1. explain the term 'alternating current'
2. describe commonly used terms related to alternating current
3. identify the key components of a simple single-phase ac generator
4. explain the difference between single-phase and 3-phase waveforms.

Range/Scope/Unit content

List 1

Describe and sketch its waveform Include:
Position of coil to magnetic field
Direction of flow on graph axis

List 2

Cycle
Periodic time
Peak value
Peak-to-peak value
Magnitude or amplitude
Frequency
Average value
RMS value
Phase

List 3

Including the arrangement of eg:
Armature
Magnets
Commutator
Brushes

List 4

Including phase angle – Φ.

Unit 101 Fundamentals of electrics and theory of flight

Outcome 4 Know about aircraft electrical devices and data transmission

Assessment Criteria

The learner can:

1. describe thermocouples
2. describe the operation of a photo-cell
3. describe the operation variable resistors
4. explain why data buses are used in aircraft
5. explain how light can be transmitted down a fibre optic cable
6. compare the properties of fibre optic data transmission to electrical wire propagation.

Range/Scope/Unit content

List 1

Basic description of the construction, operation and use:
Materials
Construction
Operation

List 2

Basic description of construction and operation

List 3

Operation and application of:
Potentiometer
Rheostat
Common uses in aircraft

List 4

Basic description
Include redundancy
Include weight saving, the need for a complex controller

List 6

Basic description:
Encode
Transmit (including internal reflection)
Boost
De-code

List 7

Information at a basic level:

Advantages of optical fibre eg:

- Faster
- More secure
- More simultaneous signals

Disadvantages of optical fibre eg:

- Greater cost
- Less robust
- More signals lost if damaged.

Unit 101 Fundamentals of electrics and theory of flight

Outcome 5 Know the forces acting on an aircraft in flight

Assessment Criteria

The learner can:

1. describe the forces acting on an aircraft in flight
2. describe the effects of streamlining an object in an airflow
3. explain how lift is produced
4. explain how a stall occurs
5. explain aerodynamic terms
6. explain the importance of the speed of sound to high-speed aircraft
7. state the meaning of terms related to high speed flight
8. describe problems that can occur when an aircraft approaches the speed of sound
9. explain design features peculiar to high-speed aircraft.

Range/Scope/Unit content

List 1

Basic description of the forces including relationship to one another
Lift
Weight
Thrust
Drag

List 2

In simple terms:
Define streamlining
Briefly explain (for subsonic) eg:
Reduction of compression shockwaves
Reduction in drag

List 3

In simple terms including:
Application of simple Bernoulli's theorem to an aerofoil (dynamic and static pressure)

List 4

Basic explanation of the development of a stall in a simple aerofoil

List 5
In simple terms:
Aerofoil
Chord line
Camber line
Angle of attack
Centre of pressure
Centre of gravity

List 6
Basic explanation
Include how speed of sound can vary with height, air density, etc

List 7
Speed of sound
Subsonic flight
Transonic flight
Supersonic flight
Mach number
M_{Crit}

List 8
Basic explanation of eg:
Shockwave
Buffet
Increased drag
Control reversal
Tuck-under

List 9
Eg simple design features of:
Wings
Fuselage
Engine intakes
Control surfaces.

Unit 101 Fundamentals of electrics and theory of flight

Outcome 6 Know about aircraft stability and control

Assessment Criteria

The learner can:

1. describe the movement of an aircraft about its three axes
2. explain the term 'equilibrium'
3. describe the relationship between lift, weight, thrust and drag in straight and level flight
4. explain the term 'static stability'
5. explain how the static stability requirements vary between different aircraft types
6. describe the design features that contribute to stability
7. explain what 'control' is with reference to conventional aircraft
8. explain 'instinctive control'
9. explain the principles of balancing control surfaces
10. explain the purpose of lift augmentation devices
11. describe how lift augmentation devices work.

Range/Scope/Unit content

List 1

Primary effects of control movement about 3 principle axes:
Pitch, roll, yaw

List 2

Basic explanation using force vectors

List 3

Describe the two couples:
Lift/weight – vertical
Thrust/drag – horizontal
Explain how the couples interact in flight

List 4

Including its main types, with reference to aircraft in flight:
Active and Passive
Lateral
Longitudinal
Directional

List 5
Eg:
Transport aircraft
Light aircraft
Combat aircraft

List 6
Lateral
Longitudinal
Directional

List 7
Simple definition of control in an aircraft context
Describe the function of basic control surfaces:

- Ailerons
- Elevator
- Rudder

Describe how pilot's controls relate to basic control surfaces

List 8
Including how control surfaces affect aircraft attitude
Simple explanation of instinctive control
Primary effects of controls:
Roll, pitch, and yaw
Simple explanation of secondary roll and yaw

List 9
Including the reason for balancing:
Describe how 'flutter' can occur
Give typical examples describing the purpose and basic methods of:
Mass balance
Aerodynamic balance

List 10
Define 'lift augmentation'
Explain the basics of why lift needs augmentation under certain flight conditions eg:
(Short) take-off and landing
Slow speed flight
High altitude take-off/landing

List 11
Basic aerodynamic principles involved
Simplified purpose and operation of:
Flaps
Slats and slots
Vortex generators
Boundary layer control.

Unit 101 Fundamentals of electrics and theory of flight

Notes for guidance

This unit provides a basic knowledge of parts of the syllabus for the EASA part 66 Category 'A' Licensed Aircraft Maintenance Engineer and provides a useful platform for training learners who wish to work as un-licensed aircraft mechanics. It also provides a lead-in to the more demanding Level 3 courses where the same subject matter is dealt with in much more depth.

Subjects are meant to be taught at a basic level to give the learner a comprehensive overview of the way in which modern aircraft are designed to operate. Basic principles should be taught in an aircraft context, and teaching of specific systems should be done using actual aircraft, parts of aircraft or comprehensive multi-media material.

Unit 102 Fundamentals of airframe construction and systems

Level: 2

Credit value: 11

UAN: H/503/0899

Unit aim

To provide learners with a basic understanding of airframe construction and their associated systems

Learning outcomes

There are **seven** learning outcomes to this unit. The learner will:

1. know the concepts of airframe structures and components
2. understand the operation of aircraft hydraulic power systems
3. understand the operation of aircraft flight control systems
4. understand the operation of aircraft landing gear systems
5. understand the operation of aircraft ice and rain protection systems
6. understand the operation of aircraft oxygen and air systems
7. know aircraft interior fittings and systems.

Guided learning hours

It is recommended that **100** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Level 2 Aeronautical Engineering NOS Unit 2

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA

Key Skills

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:

- Application of Number
- Communication
- Improving Own Learning and Performance

Assessment and grading

This unit will be assessed by:

- An internally marked short answer question paper.

Unit 102 Fundamentals of airframe construction and systems

Outcome 1 Know the concepts of airframe structures and components

Assessment Criteria

The learner can:

1. explain the need for structural strength
2. describe the construction methods used for airframe and major components
3. describe the construction and operation of door, exit and seating systems.

Range/Scope/Unit content

List 1

Overview of general concepts:

Airworthiness

Structural classification: primary secondary and tertiary

Basic fail-safe, safe life and damage tolerance concepts

Zone and station identification

Simple stress and strain eg:

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

Drains and ventilation

System installation provision

Lightning strike provision

Aircraft bonding

List 2

Simple description of:

- Stressed skin fuselage
- Formers
- Longerons
- Bulkheads
- Frames
- Floor structure
- Anti-corrosion protection

Main component attachment points eg:

Wing/ empennage/tail unit, flying controls, engine attachments, landing gear

Construction of major components eg:

Wing/empennage, flying controls, engine nacelles, firewalls, engine mounts

Riveting systems

Methods of surface protection eg: chromating, anodising, painting

Simple composite construction methods
Alignment and symmetry checks

List 3
eg doors, emergency exits, windows, windscreens, safety devices
Materials
Construction
Fitment to aircraft
Pressurisation and sealing
Seat installation and restraint systems
Cargo loading and securing systems.

Unit 102 Fundamentals of airframe construction and systems

Outcome 2 Understand the operation of aircraft hydraulic power systems

Assessment Criteria

The learner can:

1. describe aircraft hydraulic power systems
2. describe the properties of hydraulic fluids
3. describe in simple terms the indication and warning system used in a hydraulic system.

Range/Scope/Unit content

List 1

Basic layout and function of a typical system eg:

Hydraulic components

eg reservoir, pumps (electric, mechanical, pneumatic), filters, jacks and actuators, control valves, accumulators, pipelines,

Emergency pressure generation

Pressure control

Power distribution

Interface with other hydraulically powered systems

List 2

Eg:

Low compressibility

Low freezing point

Lubrication

Low foaming

Good heat transfer

Compatibility with seals

Compatibility with other fluids

List 3

Eg:

Pressure switches

Pressure transducers

Warning panel indication

Attention-getters.

Unit 102 Fundamentals of airframe construction and systems

Outcome 3 Understand the operation of aircraft flight control systems

Assessment Criteria

The learner can:

1. describe the primary flying controls used on aircraft
2. describe in secondary flying controls used on aircraft
3. describe methods of moving flying controls.

Range/Scope/Unit content

List 1

Eg:
Ailerons – roll
Elevators – pitch
Rudder – yaw
All moving tailplane – pitch
Canards– pitch and roll
Foreplanes – pitch

List 2

Lift dump
Spoilers – increase/decrease lift, roll
Flaps/slats – increase lift
Airbrakes – increase drag
Trim control
Active load control
Artificial feel
Yaw damper
Mach trim
Rudder limiter
Gust lock systems
Stall warning and protection

List 3

In simple terms:
Manual
Hydraulic
Pneumatic
Electric
Fly-by-wire
Balance and rigging.

Unit 102 Fundamentals of airframe construction and systems

Outcome 4 Understand the operation of aircraft landing gear systems

Assessment Criteria

The learner can:

1. describe aircraft landing gear systems
2. describe landing gear retraction and extension systems
3. describe landing gear shock absorber and damping systems
4. describe landing gear wheels, tyres and brakes
5. describe how anti-skid and auto-braking work
6. describe nosewheel steering systems.

Range/Scope/Unit content

List 1

Simple description of the construction and general layout of typical systems

Materials eg: Aluminium forgings, steels, magnesium alloys

Components

Layout

Attachments

Up-locks

Down-locks

Ground locks

List 2

Simple description of the construction and general layout of typical systems

Normal and emergency

Operating sequence

List 3

Simple description of the construction and general layout of typical systems

Shock absorber and damping

Materials and fluids used

List 4

Simple description of the construction and general layout of typical systems

Wheels: materials, basic design

Tyres: types of tyre, examples of what tyre ratings mean

Brakes: general layout, operation

List 5

Simple description of the construction and general layout of typical systems

Antiskid: when needed, how it operates

Autobraking: when it is used, different settings

List 6

Simple description of the construction and general layout of typical systems

Why it is needed

How steering is powered

How steering is controlled

Self-centring.

Unit 102 Fundamentals of airframe construction and systems

Outcome 5 Understand the operation of aircraft ice and rain protection systems

Assessment Criteria

The learner can:

1. describe how ice can form on aircraft
2. describe de-icing and anti icing systems
3. describe rain protection systems.

Range/Scope/Unit content

List 1

How ice forms
Classification of ice
Effect on airflow
Detection

List 2

Difference between de-icing and anti-icing
Methods eg:
Electrical
Hot air
Pneumatic
Chemical
Probe and drain heating

List 3

Rain repellent materials
Wiper systems
Blower systems.

Unit 102 Fundamentals of airframe construction and systems

Outcome 6 Understand the operation of aircraft oxygen and air systems

Assessment Criteria

The learner can:

1. describe aircraft oxygen systems
2. describe safety precautions for working with oxygen systems
3. describe the sources of aircraft air supplies
4. describe aircraft air conditioning systems
5. describe aircraft pressurisation systems.

Range/Scope/Unit content

List 1

Simple description of the construction and general layout of typical systems

Normal and emergency

Oxygen storage: Gaseous and liquid

On board oxygen generators

Supply system

Pipelines

Portable supplies

List 2

Eg:

Fire

Oils and greases

High pressures

Very low temperatures (liquid oxygen – LOX)

High temperatures (chemical generators)

List 3

Simple description of the construction and general layout of typical systems

Engine bleed

APU

Compressor

Ground test rig

Ducts

List 4

Simple description of the construction and general layout of typical systems

Purpose

Air cycle and vapour cycle machines

Flow control

Temperature control

Humidity control

Distribution system

List 5

Simple description of the construction and general layout of typical systems

Pressure control valves

Safety valves

Discharge valves

Cabin door and cockpit sealing

Indication and warning systems.

Unit 102 Fundamentals of airframe construction and systems

Outcome 7 Know aircraft interior fittings and systems

Assessment Criteria

The learner can:

1. describe examples of the layout aircraft passenger cabins
2. describe air cargo handling systems
3. describe aircraft water/waste systems.

Range/Scope/Unit content

List 1

Overview of:
Galleys
Toilets
Crew seats
Passenger seats
Ceiling, walls, and partitions
Cabin decor
Cabin furnishing & installation
Overhead lockers
Emergency equipment
Fire and smoke detection
Cabin communication and entertainment
Airstairs

List 2

Container stowage
Dangerous cargo
Loading systems eg: conveyer, rollers, fork lift
Conveyor
Rollers
Restraint systems
Fire and smoke detection

List 3

Purpose
Water and waste system layout
Toilet system layout, flushing and servicing
Corrosion aspects.

Unit 102 Fundamentals of airframe construction and systems

Notes for guidance

This unit contains part of the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 11 – Structures and Systems (11.4, 7, 9, 11-13, 15, 17, 21) for category A1 and A3 licences. 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 1 (except 1. – EASA Level 2)
Outcome 2: EASA Level 1
Outcome 3: EASA Level 1
Outcome 4: EASA Level 2
Outcome 5: EASA Level 1
Outcome 6: EASA Level 1
Outcome 7: EASA Level 1

Note: the above list equates to the EASA requirement for category A1 and A3 licences and is for guidance only. It is primarily for those learners wishing to sit the CAA examination in this subject.

Unit 103 Fundamentals of aircraft electrical and avionic systems

Level: 2

Credit value: 11

UAN: L/503/0900

Unit aim

This unit aims to give the learner a broad understanding of aircraft electrical and avionic systems as a foundation for further study for a CAA Aircraft Maintenance Engineer Licence.

Learning outcomes

There are **ten** learning outcomes to this unit. The learner will:

1. know about aircraft electrical power supply systems
2. understand aircraft electrical components and safety devices
3. know about gas turbine air start and ignition systems
4. know about aircraft electrical fuel contents indicating systems
5. know about aircraft fire protection systems
6. know about aircraft instrument systems
7. know about airborne navigational aids
8. know about aircraft communication and radar systems
9. understand software management control
10. know about automatic flight control.

Guided learning hours

It is recommended that **100** hours should be allocated for this unit. This may be on a full-time or part-time basis.

Details of the relationship between the unit and relevant national occupational standards

This unit is linked to the Aeronautical Engineering Level 2 NOS Unit 008.

Endorsement of the unit by a sector or other appropriate body

This unit is endorsed by SEMTA.

Key Skills

This unit may help candidates to gain confidence in, and possibly generate portfolio evidence for, the following Key Skills:

- Communication

Assessment and grading

This unit will be assessed by:

- An internally marked short answer question paper.

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 1 Know about aircraft electrical power supply systems

Assessment Criteria

The learner can:

1. explain aircraft power supplies
2. explain the need for a regulated power supply
3. describe aircraft batteries
4. describe the safety precautions required when working with aircraft batteries
5. describe distribution busbars
6. describe the safety precautions for working near distribution busbars.

Range/Scope/Unit content

List 1

Simple explanation of:

- AC
- DC
- Emergency/backup

List 2

Simple explanation of reason for power regulation
Methods of power supply regulation

List 3

Including and their purpose:
Lead-acid
Gel
NiCad
Primary cell (eg: Ni MH, lithium)

List 4

All relevant precautions

List 5

Simple description
Include:

- AC and DC systems
- Split and parallel systems

List 6

All relevant precautions

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 2 Understand aircraft electrical components and safety devices

Assessment Criteria

The learner can:

1. explain electrical fuses and holders
2. explain automatic circuit breakers
3. explain manually operated aircraft switches
4. explain system-operated aircraft switches
5. explain switch protection devices and guards
6. explain warning lamps and indicators
7. explain aircraft lamps and filaments.

Range/Scope/Unit content

List 1

Include: Cartridge and plug-in type, current limiters

Simple description; outline how a fuse works

Describe what a ruptured fuse looks like and the action to be taken on finding one

Explain the use of dummy fuses: red and yellow

Purpose and logging of use

List 2

Eg: surge and overload protection

Describe circuit breaker clips and guards including purpose

Typical actions following the discovery of a tripped circuit breaker

Explain the action that should be taken before manually tripping a circuit breaker

Actions following repeated tripping, including explanation of safety implications eg:

Obtain permission to disable the circuit, inform others

List 3

Purpose eg: enable direct control of aircraft systems by the crew

Types eg: toggle, push, rotary

List 4

Purpose of Eg: enable automatic initiation and sequencing of system operations triggered by pre-set conditions

Types eg:

Inertia

Micro-switch

Pressure

Thermal

Proximity

List 5
Reasons for fitting them eg: prevent inadvertent operation
Different types

List 6
Requirement for indicators
Types:
Eg: engine fire warning
Oxygen dolls eye
Master Caution
Attention-getters

List 7
Identification of eg:
- Size of glass envelope
- End fittings
- Voltage
- Wattage/current
- Other dimensions

Safety precautions eg:
- Remove power
- Cleanliness of glass
- Gaseous tritium light source (GTLS).

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 3 Know about gas turbine air start and ignition systems

Assessment Criteria

The learner can:

1. explain aircraft gas turbine starting and ignition systems
2. explain requirements of gas turbine engine starting systems
3. describe air-starting systems
4. describe the gas turbine engine start sequence
5. describe safety precautions required when working on aircraft gas turbine starting systems
6. explain High Energy Ignition Units (HEIU)
7. describe safety precautions required when working with a HEIU
8. describe safety precautions required when working on aircraft gas turbine ignition systems.

Range/Scope/Unit content

List 1

Simple explanation including main components

List 2

Eg:
Sufficient motive power to crank the compressor
Include a list of types of starting system

List 3

Simple explanation using a block diagram

List 4

Simple explanation using, for instance, a flow diagram

List 5

All precautions, on and off-aircraft eg:
Dissipation of high energy charge
Disable before starting work

List 6

Simple explanation including:
Purpose of a HEIU
The need for twin HEIUs and igniter plugs
How an HEIU works

List 7
Explain lethal voltage generated and persisting after power -off
All precautions including action before handling after power-off

List 8
All precautions on and of-aircraft

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 4 Know about aircraft electrical fuel contents indicating systems

Assessment Criteria

The learner can:

1. explain the need for an aircraft fuel contents indicating system
2. explain the layout of aircraft fuel contents indicating systems
3. explain the need for calibration of fuel contents indicating systems
4. describe safety precautions needed when working with fuel contents indicating systems .

Range/Scope/Unit content

List 1

Basic explanation including:
The importance of accurate fuel transfer
Fuel shut-off

List 2

Basic layout in block diagram form

List 3

Simple explanation including:
Safety implications of poor calibration
Advantages (including commercial) of good calibration

List 4

All precautions, on and off-aircraft.

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 5 Know about aircraft fire protection systems

Assessment Criteria

The learner can:

1. explain the need for aircraft fire detection and suppression systems
2. explain in simple terms the layout of aircraft fire detection and suppression systems
3. describe safety precautions necessary when working on aircraft fire detection and suppression systems.

Range/Scope/Unit content

List 1

Including fire in:
Cabin/cockpit
Fuel tanks
Engines
Equipment bays
Cargo hold

List 2

Basic system to block diagram level including:
Detection
Indication
Automatic initiation of extinguishers
Manual initiation of extinguishers

List 3

Including:
Explosive initiators
Delicate nature of detection wire
Prevention of inadvertent initiation.

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 6 Know about aircraft instrument systems

Assessment Criteria

The learner can:

1. explain the need for aircraft pitot-static systems
2. define pitot-static terms
3. describe components of aircraft pitot-static systems
4. describe the international standard markings on pitot and static pipework
5. explain the purpose of pitot/pressure head covers and static vent plugs
6. explain the reason for heating pitot/pressure heads
7. describe safety precautions for working on aircraft pitot-static systems
8. explain the need for aircraft instrumentation and display systems
9. describe the layout of aircraft instrument panels
10. describe safety precautions required when working with aircraft instruments.

Range/Scope/Unit content

List 1

Normal and emergency

List 2

Pitot pressure
Static pressure
Standard atmosphere
Pressure settings (QFE, QNH)
Leak rate

List 3

Eg:
Pitot/pressure head
Static vent
Pitot head heater
Air data computer
Altimeter
Airspeed indicator
Rate of climb indicator
Pitot and static pipes

List 4

Sketch and recognise

List 5
Eg:
Prevention of FOD/moisture/insect ingress
Warning flag

List 6
Including:
What happens if pitot heads are not heated
Methods of switching on/off and reasons for switching off on the ground

List 7
Eg:
Pitot head heaters
Contamination
Seals
Cracked pipes from over-tightened unions
Cross-connection

List 8
Simple explanation of why the following are needed:
Normal flight reference instruments
Normal indicating instruments
Warning indications
Emergency flight instruments
Combination instruments and glass cockpit

List 9
Generic layout
Explain basic ergonomics - the reason for standard groupings eg:
Flight instruments
Propulsion instruments
Airframe instruments
Head up display (HUD)
Multifunction displays (moving map etc)
Navigation instruments
Environment control panel
Fuel control panel
Electrical control panel
Emergency flight instruments

List 10
Safe handling eg:
Fragile
Contamination
Electrical/static damage
Sometimes physically difficult to fit

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 7 Know about airborne navigational aids

Assessment Criteria

The learner can:

1. explain the global references used in navigation
2. explain how navigation is achieved using a compass
3. explain how navigation is achieved through the use of radio
4. explain how navigation is achieved using an Inertial Navigation System
5. explain how navigation is achieved using a Global Positioning System
6. describe typical navigation system line-replaceable units (LRU).

Range/Scope/Unit content

List 1

Sufficient information to enable basic understanding in 2-5
Eg:
Latitude/longitude
Heading
Bearing
True north
Magnetic north
Azimuth
Simple explanation of 'great circle route'

List 2

Simple explanation of how heading information is not sufficient on its own
Additional parameters required eg:

- Speed
- Time
- Pinpoint fixes

Types of compass eg:

- Magnetic
- Remote reading

List 3

Simple explanation of:
ADF
VOR
DME
ILS (Glideslope and Localiser)
Triangulation
Accuracy

List 4
Simple explanation eg:
INS with no more than basic maths
Accuracy and common errors that can occur
Use of twin units to cancel errors
Combination with other navigation systems

List 5
Simple explanation eg:
Position of satellites
Information acquired from satellites
Basic calculations made

List 6
Representative selection of common instruments and units eg:
Horizontal Situation Indicator (HSI)
Inertial Navigation Unit (INU)
Multifunction Display (MFD
GPS receiver
Navigation Management Unit.

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Outcome 8 Know about aircraft communication and radar systems

Assessment Criteria

The learner can:

1. describe aircraft communication systems
2. describe intercom systems
3. describe V/UHF radio systems
4. describe HF radio systems
5. describe the uses of secure communications
6. describe the main LRUs in an aircraft communication system
7. describe the basic principles of primary radar
8. describe the use of airborne radar to detect weather
9. describe the use of radar as an aircraft altimeter
10. describe the use of radar to determine aircraft speed
11. describe the basic principle of secondary radar
12. describe the use of SSR/IFF
13. describe cockpit LRUs that use and display radar information.

Range/Scope/Unit content

List 1

Available to aircraft crew and passengers eg:
Crew intercom
PA system
V/UHF
HF
Satcom
Data link

List 2

In simple terms including:
Purpose
Normal use
Emergency use

List 3

In simple terms including:
Purpose
Approximate frequency range
Operating distances
Limitations

List 4
In simple terms including:
Approximate frequency range
Operating distance
Limitations

List 5
In simple terms including:
Military use
Civilian use
Frequency agile
Encrypted digital transmission

List 6
In simple terms including:
Transmitter/receivers
Antennae
HF antenna tuning unit
Control units
Headsets and amplifiers
Mobile phone equipment

List 7
Basic explanation of eg:
Purpose
Transmission of radar beam
Reflection of beam
Painting of reflected beam on a screen
Measurement of distance
Ground mapping

List 8
In simple terms including:
Primary radar used to detect weather features
Weather radar detects precipitation (pulsed)
Some weather radars can detect turbulence (Doppler)

List 9
In simple terms including:
Radar used as vertical distance measuring equipment
Time measured for a transmitted pulse to return
Time measurement converted to distance and displayed
Pulse repetition frequency (PRF)

List 10
Simple explanation of the Doppler Effect
Frequency difference between transmitted and received pulses
Difference converted to speed and displayed

List 11
In simple terms including:
Does not require a reflection
Pulsed signal carries data
Received by a transponder
Transponder responds with more data

List 12
In simple terms including:
SSR/IFF is secondary radar
Interrogation pulse can be encoded
Transponder linked to altimeter etc
Can transmit codes such as hijack, Mayday etc
ACAS and Mode 'S'

List 13
In simple terms including:
Multi function display (MFD)
Weather radar display
IFF/SSR control unit.

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 9 Understand software management control

Assessment Criteria

The learner can:

1. explain why software and loading devices are required on many aircraft
2. explain the need for software management
3. explain the principles of communication security (COMSEC)
4. explain the use of a central maintenance computer system (CMCS)
5. explain the use of an electronic library in a maintenance environment.

Range/Scope/Unit content

List 1

Include: updates for computer controlled systems and connections for test equipment

List 2

Include: record keeping; standardisation

List 3

Include: data security; unauthorised modification

List 4

Simple description of major components and their purpose

List 5

Include benefits and drawbacks

Unit 103 Fundamentals of aircraft electrical and avionic systems

Outcome 10 Know about automatic flight control

Assessment Criteria

The learner can:

1. explain the need for auto-stabilisation on an aircraft
2. explain the basic principles of auto-stabilisation
3. explain the need for an autopilot system on an aircraft
4. describe the basic modes of autopilot operation
5. describe the sensors required in each of the basic modes
6. explain how the autopilot operates in each of the basic modes
7. explain the need for Stick Force Cut Outs (SFCO) and Instinctive Cut Outs (ICO).

Range/Scope/Unit content

List 1

Simple explanation using diagrams and /or a model

Long and short period disturbances causing departures from the flight path etc

List 2

Eg:

Applying a correction quicker and more accurately than the pilot can

Sensing

Measuring rate ad direction

Applying corrective control movement

List 3

Eg:

Alleviate crew fatigue on long flights

Fly a pre-determined course accurately

Provide smooth safe flight

List 4

Pitch

Roll

Yaw

Plus:

Height

Speed

Heading

List 5

Eg:

Rate gyros (eg: mechanical, laser)

Air data

Compass data

List 6

Simple explanation using diagrams and/or a model

List 7

Eg:

SFCO – automatic safety cut-out in the event of a system fault or control problem

ICO – enables the pilot to manually take control of the aircraft

Unit 103 Fundamentals of aircraft electrical and avionic systems

Notes for guidance

This unit provides a basic knowledge of parts of the syllabus for the EASA part 66 Category 'A' Licensed Aircraft Maintenance Engineer and provides a useful platform for training learners who wish to work as un-licensed aircraft mechanics. It also provides a lead-in to the more demanding Level 3 courses where the same subject matter is dealt with in much more depth.

Subjects are meant to be taught at a basic level to give the learner a comprehensive overview of the way in which modern aircraft are designed to operate. Basic principles should be taught in an aircraft context, and teaching of specific systems should be done using actual aircraft, parts of aircraft or comprehensive multi-media material.

Appendix 1 Relationships to other qualifications

Literacy, language, numeracy and ICT skills development

This qualification 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, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

Our Quality Assurance Requirements encompasses all of the relevant requirements of key regulatory documents such as:

- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

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
- **Events**: dates and information on the latest Centre events
- **Online assessment**: how to register for e-assessments.

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, e-assessment, 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).

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City & Guilds
1 Giltspur Street
London EC1A 9DD
T +44 (0)844 543 0000
F +44 (0)20 7294 2413
www.cityandguilds.com

WW-02-2675