QUALIFICATION HANDBOOK

Level 3 Diploma in Aircraft Maintenance (Military Aircraft Electrical and Avionics) (2675-03)

September 2017 Version 1.4

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 for this qualification is suitable for applicants who have five GCSEs grades C and above in English, Maths and Science.
Assessment	Assignment, 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 3 Diploma in Aircraft Maintenance (Military Aircraft Electrical and Avionics)	575	720	2675-03	600/1971/2

Version and date	Change detail	Section
1.1 June 2013	Amended Unit 30	**Units**
1.2 March 2014	Correction in unit 203 - Density: kgm^{-2} to Density: kgm^{-3}	**Units**
1.3 June 2014	Amended Test Spec 5	**Test Spec**
1.4 September 2017	Added TQT details Deleted QCF	**Qualification at a glance and Structure** **Throughout**
V2 February 2019	Removed range from Unit 203 Outcome 1 List 3 Corrected layout and numbering	**Unit 203** **All units**

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 require a total of **72 credits** to achieve the Level 3 Diploma in Aircraft Maintenance (Military Aircraft Electrical and Avionics).

Learners can obtain a further 5 credits from the Elective Unit 111. However, these credits do not contribute to the required minimum for the qualification.

Mandatory Units

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
T/503/0888	Unit 030	Digital techniques and electronic instrument systems in aircraft	9
M/503/1263	Unit 035	Human factors in aviation	5
A/503/0956	Unit 201	Fundamentals of electronics and avionics	10
L/503/0959	Unit 202	Military policy and regulation in aviation	4
D/503/0965	Unit 203	Aerodynamics and control in a fixed-wing aircraft	5
J/503/1107	Unit 208	Maintaining aircraft electrical cables	10
J/503/1110	Unit 209	Electronics in aircraft	9
T/503/1216	Unit 210	Maintaining avionic and electrical systems in aircraft	12
D/503/1128	Unit 215	Aviation mathematics and science for technicians	8

Elective Unit

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
D/503/0951	Unit 111	Working safely with aircraft armament systems	5

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 3 Diploma in Aircraft Maintenance (Military Aircraft Electrical and Avionics)	575	720

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
2675-030	Digital techniques and electronic instrument systems in aircraft	CAA or Short-Answer
2675-035	Human factors in aviation	e-assessments
2675-201	Fundamentals of electronics and avionics	e-assessments
2675-202	Military policy and regulation in aviation	Centre Devised Assignment
2675-203	Aerodynamics and control in a fixed-wing aircraft	e-assessments
2675-208	Maintaining aircraft electrical cables	Centre Devised Assignment
2675-209	Electronics in aircraft	Centre Devised Assignment
2675-210	Maintaining avionic and electrical systems in aircraft	Centre Devised Assignment
2675-215	Aviation mathematics and science for technicians	e-assessments

Elective Unit

City & Guilds unit number	Unit title	Assessment method
2675-111	Working safely with aircraft armament systems	Centre Devised Assignment

Online multiple-choice assessments

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

Centre set assignments

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

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

Approval process for centre set assignments

Centre set assignments must be approved by the external verifier before use. For each assignment, the *assignment sign off sheet* (AD3) must be completed and be made available to the EV for inspection.

Time constraints

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

Test specifications

Test 1: Unit 030 Further Digital Techniques and Electronic Instrument Systems in Aircraft Level 3

Duration: 45 or 60 minutes

Outcome	Number of questions	%
01 Understand electronic flight instrument systems (EFIS)	4	10.5
02 Understand numbering systems and data methods	6	12.5
03 Understand data buses and the standards applying to them	3	8
04 Understand the operation of logic circuits and microprocessors	4	11.5
05 Understand computer structure and the principles of software management control	5	12.5

06 Understand the principles of multiplexing	3	6.5
07 Understand fibre-optic principles and their application in aircraft	4	10.5
08 Understand the principles of displays used in modern aircraft	3	9
09 Understand electrostatic sensitive devices and the electromagnetic environment	4	9
10 Understand the general arrangement of typical electronic/digital aircraft systems and BITE.	4	10
Total	**40**	**100**

Test 2: Unit 035 Human Factors in Aviation
Duration: 60 minutes

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

Test 3: Unit 201 Fundamentals of electronics and avionics
Duration: 90 minutes

Outcome	Number of questions	%
01 Understand the principles of electrical current and charge	9	15
02 Understand the principles of aircraft electrical power generation	8	13
03 Understand the principles and uses of aircraft batteries	7	12
04 Understand the use of aircraft cables and associated devices	8	13
05 Understand aircraft cabling tasks	1	2
06 Understand aircraft power supplies	7	12
07 Understand aircraft flight instruments and lighting systems	7	12
08 Understand digital aircraft control and monitoring systems	13	22
Total	**60**	**100**

Test 4: Unit 203 Aerodynamics and control in a fixed-wing aircraft
Duration: 90 minutes

Outcome	Number of questions	%
01 Know the basic properties of the Earth's atmosphere	4	7
02 Understand the nature of airflow around aerodynamic bodies	13	22
03 Understand the characteristics of the basic wing planforms	4	6
04 Understand the principles of aircraft control	9	15
05 Understand the principles of aircraft stability	7	12
06 Understand the purpose and operation of secondary flying control surfaces	10	16
07 Understand methods of balancing and trimming control surfaces	6	10
08 Understand the basic theory of high speed flight	7	12
Total	**60**	**100**

Test 5: Unit 215 Aviation mathematics and science for technicians
Duration: 105 minutes

Outcome	Number of questions	%
01 Be able to use principles of arithmetic	8	11.5
02 Be able to use SI, Imperial and US customary units	7	10
03 Be able to manipulate algebraic expressions and formulae using standard techniques	7	10
04 Be able to calculate physical properties of common two and three dimensional shapes	5	7
05 Be able to use graphs to determine values and solve engineering problems	6	8.6
06 Understand the nature of matter	9	12.9
07 Understand principles of statics	9	12.9
08 Understand principles of linear, angular and oscillating motion related to aircraft in flight	8	11.4
09 Understand principles of dynamics related to aircraft in flight	7	10
10 Understand principles of fluid motion related to aircraft in flight.	4	5.7
Total	**70**	**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 030 Digital techniques and electronic instrument systems in aircraft

Level: **3**
Credit value: **9**
UAN: **T/503/0888**

Unit aim

This unit aims to give the learner an understanding of digital principles to enable further study of digital avionics systems. It contains the complete syllabus of Module 5 for category B2 licences.

Learning outcomes

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

1. understand electronic flight instrument systems (EFIS)
2. understand numbering systems and data methods
3. understand data buses and the standards applying to them
4. understand the operation of logic circuits and microprocessors
5. understand computer structure and the principles of software management control
6. understand the principles of multiplexing
7. understand fibre-optic principles and their application in aircraft
8. understand the principles of displays used in modern aircraft
9. understand electrostatic sensitive devices and the electromagnetic environment
10. understand the general arrangement of typical electronic/digital aircraft systems and BITE.

Guided learning hours

It is recommended that **70** 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 – numerous units

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
- Information and Communication Technology
- Improving Own Learning and Performance

Assessment and grading

This unit will be assessed by:

- An internally marked short answer question paper.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 1 Understand electronic flight instrument systems (EFIS)

Assessment Criteria

The learner can:

1. explain the reasons for the ergonomic layout of an aircraft flight deck or cockpit
2. describe primary flight displays (PFD)
3. describe multi-function displays (MFD)
4. describe engine indicating and crew alerting systems (EICAS).

Range/Scope/Unit content

List 1

For a typical flight deck/cockpit eg:

Information priorities, ease of access, minimum distraction, positioning of information sources

List 2

The arrangement for a typical system:

Information sources, control units, layouts, monitoring, data processing alerting methods

List 3

The arrangement for a typical system:

Information sources, control units, layouts, monitoring, data processing, alerting methods

List 4

The arrangement for a typical system:

Information sources, control units, layouts, monitoring, data processing, alerting methods.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 2 Understand numbering systems and data methods

Assessment Criteria

The learner can:

1. explain the need for different numbering systems
2. explain the structure and rules of binary
3. explain the structure and rules of octal
4. explain the structure and rules of hexadecimal
5. convert numerical values between number systems
6. explain the principles of analogue-to-digital conversion
7. explain the principles of digital-to-analogue conversion.

Range/Scope/Unit content

List 1

Related to electronics and digital systems

Reasons why the base 10 system is generally not suitable for electronic systems

List 2

Including definitions of bit, byte, kilo, mega, tera

Binary Coded Decimal (BCD)

Uses in digital systems

Make simple calculations

List 3

Uses in digital systems

Make simple calculations

List 4

Uses in digital systems including use in representing memory addresses

Make simple calculations

List 5

Binary, binary coded decimal (BCD), hexadecimal, octal and decimal

Including use of tables

Learners should be able to readily convert four or five digit decimal values between systems

List 6

Including:

Positive and negative logic

Operation and application of A-D converters in aircraft systems

Inputs, outputs and limitations of a range of convertors

List 7

Including

Operation and application of D-A converters in aircraft systems.

Inputs, outputs and limitations of a range of convertors.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 3 Understand data buses and the standards applying to them

Assessment Criteria

The learner can:

1. explain data buses in aircraft systems
2. describe components of a data bus and their function
3. describe common data bus standards
4. explain the principles of data bus protocols.

Range/Scope/Unit content

List 1

Define the term 'data bus'

Explain the purpose of data buses applied to:

A range of civil and military systems with particular focus on at least one civil or military system

Data bus families eg: ARINC, Military

List 2

Typical components of aircraft data bus systems eg:

Transceiver, controller, cabling, fibre-optics

Aircraft Network/Ethernet

List 3

Describe their features and applications eg: ARINC 429, ARINC 629, MIL-STD-I 553 (DEF STAN 00-18)

List 4

Including the definition and composition of a databus word, explanation of error detection, parity and application of individual databus standards to types of aircraft system.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 4 Understand the operation of logic circuits and microprocessors

Assessment Criteria

The learner can:

1. explain logic gate symbols, tables and equivalent circuits
2. describe typical aircraft applications of logic circuits
3. explain the circuits represented by schematic diagrams of logic circuits
4. describe the basic layout and uses of a typical microprocessor
5. describe the operation of key components of a typical microprocessor.

Range/Scope/Unit content

List 1

AND, OR, NAND, NOR, NOT (invertor), XOR, XNOR

Symbols, truth tables, equivalent circuits

List 2

Practical examples relevant to the learner

List 3

Typical aircraft-related circuits

List 4

A typical generic microprocessor

List 5

Including: control and processing unit, clock, register, arithmetic logic unit.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 5 Understand computer structure and the principles of software management control

Assessment Criteria

The learner can:

1. explain computer related terminology
2. describe avionic computers
3. describe the operation of typical memory devices used in avionics
4. describe aircraft data storage systems
5. explain the issues surrounding aircraft software and its control.

Range/Scope/Unit content

List 1

Basic terminology eg: CPU, RAM, ROM, PROM, bus, interface

List 2

The layout, operation and interfaces of typical computers eg:

Inputs, outputs, processors, memory devices

List 3

Eg: RAM, ROM, PROM, EPROM, hard disk, CD/DVD, flash drive

List 4

Operation, advantages and disadvantages of typical data storage

List 5

Possible consequences of unauthorised and un-recorded software changes

Restrictions on changes and recording

Airworthiness requirements for the development and implementation of software changes.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 6 Understand the principles of multiplexing

Assessment Criteria

The learner can:

1. define multiplexing
2. explain why multiplexing is required how it is achieved
3. describe typical applications of multiplexing.

Range/Scope/Unit content

List 1

Basic definition

List 2

Eg: efficient use of transmission media
Multiplexers
Demultiplexers
Identification in logic diagrams

List 3

In avionic systems relevant to the learner.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 7 Understand fibre-optic principles and their application in aircraft

Assessment Criteria

The learner can:

1. describe aircraft fibre-optic cable
2. describe how fibre-optic cable is terminated
3. explain the advantages and disadvantages of using fibre-optics
4. describe the layout and operation of a fibre-optic data bus
5. describe applications of fibre optics in aircraft systems.

Range/Scope/Unit content

List 1

The construction and operation of typical eg:

Materials used, relative refractive indices, internal reflection, signal capacity

List 2

Typical methods eg: types of termination, preparation, importance of clean cut and polishing surfaces, care of outer casing when installing and working near fibre-optics

List 3

As against electrical wire eg: weight, reliability, cost, signal density, faultfinding, maintenance

List 4

Typical example eg: couplers, control terminals, remote terminals

List 5

Typical applications relevant to the learner.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 8 Understand the principles of displays used in modern aircraft

Assessment Criteria

The learner can:

1. explain how aircraft liquid crystal displays (LCD) function
2. explain how aircraft Light Emitting Diode (LED) displays function
3. explain how aircraft Cathode Ray Tube (CRT) displays function.

Range/Scope/Unit content

List 1

The principles and operation of typical displays:
Monochrome
Colour
Handling precautions

List 2

The principles and operation of typical displays
Monochrome
Colour
Handling precautions

List 3

The principles and operation of typical displays:
Monochrome
Colour
Handling precautions.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 9 Understand electrostatic sensitive devices and the electromagnetic environment

Assessment Criteria

The learner can:

1. define what is meant by an electrostatic sensitive device
2. describe the damage that could be caused to an SSD by static discharge
3. describe the protection that can be applied to SSDs
4. explain the principles of electromagnetic phenomena.

Range/Scope/Unit content

List 1

Basic definition including aircraft-related examples

List 2

Including precautions that can be taken by personnel to prevent static damage eg: size of voltage generated in a discharge, types of discharge, immediate complete failure, delayed failure, intermittent failure, reduced performance

List 3

Eg: in-built protection by design, external in-circuit protection, shielding

Handling precautions, earthing straps, grounded mats and work surfaces

List 4

Including their influence on aircraft electronic system maintenance

Description, implications, precautions and measures to ensure Electromagnetic Compatibility (EMC) and to prevent and protect from:

Electromagnetic Interference (EMI)

High Intensity Radiated Field (HIRF)

Lightning.

Unit 030 Digital techniques and electronic instrument systems in aircraft

Outcome 10 Understand the general arrangement of typical electronic/digital aircraft systems and BITE

Assessment Criteria

The learner can:

1. describe the general arrangements of digital/electronic aircraft systems
2. describe Built In Test Equipment (BITE) testing in digital/electronic aircraft systems.

Range/Scope/Unit content

List 1 and List 2

A range of typical systems relevant to the learner eg:
ACARS-ARINC Communication and Addressing and Reporting System
ECAM-Electronic Centralised Aircraft Monitoring
EFIS-Electronic Flight Instrument System
EICAS-Engine Indication and Crew Alerting System
FBW-Fly by Wire
FMS-Flight Management System
GPS-Global Positioning System
IRS-Inertial Reference System
TCAS-Traffic Alert Collision Avoidance System
Integrated Modular Avionics
Cabin Systems
Information Systems.

Unit 030 Digital techniques and electronic instrument systems in aircraft

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 Quality Assurer.

This unit contains the complete syllabus of EASA 2042/2003 (amended by 1149/2011)part 66 Basic Knowledge Requirements Module 5 – Digital Techniques Electronic Instrument Systems, dated 16 Sept 2010, fully effective1 June 2013. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B2 category - are listed below with an abridged description of each level:

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

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

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

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.

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 is 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 i 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 111 Working safely with aircraft armament systems

Level: 2
Credit value: 5
UAN: D/503/0951

Unit aim

The aim of this unit is to give learners a solid grounding in safe working on aircraft fitted with armament systems and assisted escape systems (AAES).

Learning outcomes

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

1. understand explosive safety
2. understand aircraft assisted escape systems (AAES)
3. know aircraft armament role equipment
4. know aircraft stores management systems
5. know aircraft gun systems
6. know aircraft missiles
7. understand aircraft countermeasure systems
8. know aircraft weapons
9. understand safety precautions for armed aircraft

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

(Note: due to the safety implications of this unit, and its product-specific content, the assessment must be centre-set. The pass-mark will be 100% in this case, which is the industry standard.

This unit will be assessed by:

- Centre-set multiple –choice test covering underpinning knowledge
- Centre-set practical assessment.

Unit 111 Working safely with aircraft armament systems

Outcome 1 Understand explosive safety

Assessment Criteria

The learner can:

1. describe what explosives are and how they are categorised
2. describe the Explosive Train
3. explain explosive lifing
4. describe the dangers of static electricity and explosive devices
5. define thunderstorm risk categories and actions
6. describe general explosive safety rules
7. describe dangers involving armed aircraft
8. state the use of role colours and hazard application bands on explosive devices
9. describe the United Nations classification of explosives
10. describe the dangers in relation to Radio Frequency hazards and Explosive devices.

Range/Scope/Unit content

List 1

Define the term 'explosive'
Define terms related to explosives:
Velocity of Detonation
Figure of Power
Figure of Insensitivity
Describe the hierarchy of explosives
Describe the difference between Low and High Explosive

List 2

Eg:
Step-up-System of Detonation
Low explosive train (eg: primer – igniter – propellant)
High explosive train eg:
Two-step (eg: detonator – explosive)
Three step (eg: detonator – booster – main charge)

List 3

Eg:
How explosives deteriorate over time
Effects of environment (temperature, humidity etc)
Labelling and recording of manufacture and expiry dates

List 4

Eg: potential to detonate when in contact with static discharge

List 5

Thunderstorm Category and Definition:

Category 1 (High) - Thunderstorms will develop / have developed in the area

Category 2 (Moderate) - Thunderstorms may develop in the area

Category 3 (Low) - Thunderstorms are not expected in the area. Category and Definition

List 6

General and organisation-specific rules contained in eg:

BAe Systems Explosive and Prohibited Weapons Safety (QMS)

JAP 100A

List 7

Armed aircraft danger areas potential risks

Eg:

Front – Guns, Missiles and Rockets.

Rear – Missiles, Rockets, Chaff and Flare, Towed Decoy, Smoke Marker/Sonar buoy Discharger.

Generally- Bombs, Ejector Release Units, Drop Tanks, Explosive Start Valves

List 8

Colour Coding and Marking of Stores:

Explosive stores carry markings used to indicate:

Primary role

Degree of danger or hazard to personnel who come in contact or handle them

List 9

Reason eg: to facilitate fire fighting

Explosives and ammunition divided according to their behaviour when involved in a fire

Symbols: orange coloured with black numerals denoting the fire division

List 10

Eg: spontaneous detonation of EEDs in the presence of external RF radiation

Define ‘intrinsically safe’.

Unit 111 Working safely with aircraft armament systems

Outcome 2 Understand aircraft assisted escape systems (AAES)

Assessment Criteria

The learner can:

1. describe ejection seats fitted to military fast-jet aircraft
2. describe ejection seat major assemblies
3. describe the purpose of ejection seat components
4. describe Command Ejection systems
5. describe Canopy Jettison and Fragmentation Systems.

Range/Scope/Unit content

List 1

One or more seats eg: Tornado, Typhoon
Including safety pin positions and other device selections for:
Safe for Parking
Safe for Maintenance

List 2

Description of:
BTRU
Drogue Gun
Head Box
Top Latch Assembly
Firing Units
Cartridges
Main Gun
QRF
Rocket Pack

List 3

Locate and explain the purpose of:
Main beam assembly
Main Gun Assembly
Top Latch Assembly
Seat pan Assembly
Parachute harness and head box
Quick Release Fittings (QRF)
Barostatic Time Release Unit (BTRU)
Drogue Gun/Parachute Deployment Unit (PDU)
Emergency Oxygen System (EO2)
Leg/Limb Restraint Systems
Harness Power Retraction Unit (HPRU)
Personal Equipment Conector (PEC)
Personal Survival Pack (PSP)

Auto Deployment Unit (ADU)
Auto Liferaft Inflation Unit (ALIU)
Trip rods
Armed/Safe/Egress Handle

List 4
For specific aircraft eg: Tornado, Typhoon:
Command Control Valve
Command Ejection Controller
Command Mode Selector

List 5
For specific aircraft eg: Tornado, Typhoon eg:
MDC
CLC.

Unit 111 Working safely with aircraft armament systems

Outcome 3 Know aircraft armament role equipment

Assessment Criteria

The learner can:

1. identify types of suspension lugs
2. identify items of carriage and release equipment used on aircraft
3. explain the operation of carriage and release equipment.

Range/Scope/Unit content

List 1

Purpose of including:
Bail Lugs
MACE Lugs

List 2

Including:
Wing Pylons
Fuselage Pylons
Twin Store Carrier (TSC)
Carrier Bomb Light Store (CBLS)
Ejector Release Units (ERU): No.122EX; LDERU; HDERU; ALDERU; AHDERU
Fuzing Units

List 3

Operation and purpose of including:
Wing Pylons
Fuselage Pylons
Twin Store Carrier (TSC)
Carrier Bomb Light Store (CBLS)
Ejector Release Units (ERU)
Fuzing Units.

Unit 111 Working safely with aircraft armament systems

Outcome 4 Know aircraft stores management systems (SMS)

Assessment Criteria

The learner can:

1. state the purpose of a SMS
2. identify the components of the SMS.

Range/Scope/Unit content

List 1

For typical aircraft:
Requirement for managing armament stores
Basic function of the SMS

List 2

Including:
Weapon Programming Unit
Weapon Control Panels
Attack / Weapon Release Button
Master Armament Safety Switch (MASS)
Late Arm Switch
Selective / Emergency Jettison
Trigger
Armament System Ground Test Switch (ASGTS).

Unit 111 Working safely with aircraft armament systems

Outcome 5 Understand aircraft gun systems

Assessment Criteria

The learner can:

1. state the purpose of aircraft gun systems
2. identify components of aircraft gun systems
3. explain the operation of aircraft gun systems.

Range/Scope/Unit content

List 1

Specific aircraft eg: Tornado, Typhoon

List 2

Locate and name components eg:
Breech
Barrel
Cocking mechanism

List 3

Eg:
Loading ammunition tanks
Cocking
Firing
Spent case ejection
Ammunition feed
Live round insertion.

Unit 111 Working safely with aircraft armament systems

Outcome 6 Know aircraft missiles

Assessment Criteria

The learner can:

1. identify Air-to-Air & Air-to-Ground missiles
2. identify components of an air-to-air missile
3. explain the operation of an air-to-air missile.

Range/Scope/Unit content

List 1

Identify and name missiles eg:
Sidewinder
ASRAAM
Brimstone
ALARM

List 2

Identify and name components of eg: Sidewinder

List 3

Explain the purpose and operation of eg: Sidewinder.

Unit 111 Working safely with aircraft armament systems

Outcome 7 Understand aircraft countermeasure systems

Assessment Criteria

The learner can:

1. identify countermeasure systems used on aircraft
2. state the purpose of countermeasure systems
3. explain the operation of countermeasure systems.

Range/Scope/Unit content

List 1

Eg:
Chaff
Flare

List 2

Eg: to disrupt and distract enemy airborne target acquisition systems

List 3

Including:
Chaff dispensers and the action of chaff
Flare dispensers and the action of flares.

Unit 111 Working safely with aircraft armament systems

Outcome 8 Know aircraft weapons

Assessment Criteria

The learner can:

1. identify bomb types including
2. identify major bomb components
3. identify role and hazard colour coding.

Range/Scope/Unit content

List 1

Eg:
3kg and14kg practice bombs

List 2

Tail units
Shear Wires
Lead Electrical Fuzing and Arming (LEFA)

List 3

Colour Coding and Marking of Stores

Unit 111 Working safely with aircraft armament systems

Outcome 9 Understand safety precautions for armed aircraft

Assessment Criteria

The learner can:

1. understand safety precautions relating to armed aircraft.

Range/Scope/Unit content

List 1

Including:

Aircraft Armed signs
Safe Approach to the aircraft
Angle of approach
Check the Master Armament Safety Switch
Undercarriage locks and earthing leads.

Unit 111 Working safely with aircraft armament systems

Notes for guidance

This unit has been designed to cover the essential safety knowledge required by all personnel working on or near aircraft that are fitted with any weapon or device that includes explosive charges. The nature of the subject requires a clear, unambiguous understanding of all of the safety rules, instructions and procedures and this unit allows recognition of an individual's achievement of that understanding. The knowledge in this unit will be assessed by both written and practical (walk-through) means to ensure that the learner is able to relate class-room knowledge to real working environments.

Unit 201 Fundamentals of electronics and avionics

Level: 3
Credit value: 10
UAN: A/503/0956

Unit aim
This unit aims to give the learner sufficient knowledge of aircraft electrical and avionic principles to allow further study on specific systems.

Learning outcomes
There are **eight** learning outcomes to this unit. The learner will:
1. understand the principles of electrical current and charge
2. understand the principles of aircraft electrical power generation
3. understand the principles and use of aircraft batteries
4. know the use of aircraft cables and associated devices
5. understand aircraft cabling tasks
6. understand aircraft power supplies
7. understand aircraft flight instruments and lighting systems
8. understand digital aircraft control and monitoring systems

Guided learning hours
It is recommended that **75** 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 121, 123 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
- Information and Communication Technology
- 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 201 Fundamentals of electronics and avionics

Outcome 1 Understand the principles of electrical current and charge

Assessment Criteria

The learner can:

1. describe the structure of the atom
2. describe the distribution of electrical charge in different types of particle
3. describe the molecular structure of electrical materials
4. explain the principle of attraction and repulsion of charged particles
5. explain electrical conduction in different media
6. describe the nature of static electricity
7. describe safety precautions associated with static electricity
8. define terms associated with electricity
9. Illustrate the relationship between voltage, current, resistance and power.

Range/Scope/Unit content

List 1

To a depth which allows understanding of:

Electrical current

Static electricity

Molecules

Compounds

List 2

Atom

Molecule

Compound

List 3

To a depth which allows understanding of:

Electrical current

Operation of semi-conductors

Electrical resistance

Conductors

insulators

List 4

Simple explanation

Including Coulomb's Law

List 5

Solid, liquid, gas, vacuum

List 6

Eg:

Mechanism of formation of static electricity (friction then separation of different materials)

Types of materials

Environmental conditions

Generation of high discharge voltages

Potential to damage semiconductors etc

Practical examples

List 7

With practical, aircraft-related examples eg:

Refuelling

Conductive tyres

Workshop practice

Lox plants

List 8

Including SI and Imperial (where appropriate) units for each:

Coulomb

Charge

Current

Resistance

Conductance

Electron flow

Conventional current flow

Potential difference

Electromotive force

Voltage

Electrical power

List 9

Practically and theoretically:

Ohms Law

Kirchhoff's Current and Voltage Laws

Series and parallel

Solve practical problems

Unit 201 Fundamentals of electronics and avionics

Outcome 2 Understand the principles of aircraft electrical power generation

Assessment Criteria

The learner can:

1. describe how electricity can be produced using a range of methods
2. explain how to calculate the internal resistance of a battery
3. describe the features of a sinusoidal waveform
4. explain terms relating to a sinusoidal waveform
5. describe the features of other common wave forms
6. make calculations relating to alternating current, voltage and power
7. describe a range of sensors.

Range/Scope/Unit content

List 1

Including:

Light (photoelectric cells)

Heat Thermocouples)

Pressure (piezoelectric)

Chemical action (battery)

Magnetism and motion (generators)

List 2

Standard calculation

Include the effects of internal resistance on an electrical circuit

List 3

Including definitions of:

Phase

Frequency

Cycle

List 4

Sinusoidal values:

Instantaneous

Average

Root mean square

Peak

Peak-to-peak

List 5
Triangular (saw-tooth)
Square

List 6
Calculations for:
Instantaneous
Average
Root mean square
Peak
Peak-to-peak

List 7
The construction, operation and typical aircraft applications of eg:
Piezoelectric crystal
Thermocouple
Photoelectric cell/Light Dependent Resistor (LDR)
“Firewire”.

Unit 201 Fundamentals of electronics and avionics

Outcome 3 Understand the principles and uses of aircraft batteries

Assessment Criteria

The learner can:

1. explain the chemical action of electrical cells
2. describe aircraft batteries
3. explain how the state of charge of aircraft batteries can be determined
4. describe the mandatory safety precautions for the servicing of aircraft batteries
5. describe maintenance procedures for aircraft batteries
6. explain how aircraft batteries are capacity-tested
7. explain constant voltage and constant current charging of aircraft batteries
8. explain 'thermal runaway'

Range/Scope/Unit content

List 1

Basic principles
Qualitative explanation of action
Primary and secondary cells
Standard cell voltages

List 2

Construction and operation of typical:
Dry battery
Lead-acid battery
Nickel-cadmium battery
Other alkaline cells

List 3

Using standard procedures

List 4

Including during:
Charging
Testing
Transportation
Installation
Removal

List 5

Lead-acid
Nickel-cadmium

List 6
Explaining how and why, including:
Definition of capacity
Why capacity reduces
Consequences of un-noticed reduction in capacity
Minimum permissible capacity

List 7
Define constant current
Basic explanation of constant current charging
How and why it is done

List 8
Including:
How thermal runaway happens
Consequences of thermal runaway
How to avoid thermal runaway

Unit 201 Fundamentals of electronics and avionics

Outcome 4 Understand the use of aircraft cables and associated devices

Assessment Criteria

The learner can:

1. describe aircraft cables
2. explain the effect on performance of individual cables when placed in a loom or conduit
3. describe connector types used in aircraft
4. describe crimping tools used in aircraft applications
5. demonstrate the use of wire selection charts
6. describe installation procedures for aircraft cable looms
7. describe the process of soft soldering
8. describe the function and use of general aircraft test equipment
9. describe techniques for testing aircraft cables
10. explain aircraft electrical safety devices.

Range/Scope/Unit content

List 1

Define EWIS (Electrical Wiring Interconnection System)
The construction and purpose of typical cables eg:
High tension
Co-axial
'Kapton' (explain special safety issues)
Special-purpose
General purpose

List 2

Eg:
Reduced current-carrying
Possible signal interference

List 3

Eg connectors used for:
High tension
Power
Data
Communications
Fibre-optics

List 4

Full range of aircraft-use tools for, including:
Ring tongue terminals
Splices
Miniature connectors

Explain:
Construction and operation
Calibration and pre-use checks
Consequences of using an incorrectly calibrated crimp tool

List 5
Explain why and how they are used
Demonstrate using standard industry tables

List 6
Eg:
Safety precautions
Routing
Securing
Protection
Cooling
Screening
Individual cables
Looms
Connectors and connector pins

List 7
When and how it would be used including:
Flux
Solder composition
Heat sources
Cleanliness
Application
Joint inspection

List 8
Electrical and avionic general test equipment including:
Ammeter
Voltmeter
Multimeter (analogue and digital)
Basic oscilloscope

List 9
Including:
Automatic test equipment
Multimeter
Continuity tester
Insulation tester
Time Domain Reflectometer (TDR)

List 10
The function and use of devices such as:
Relays
Fuses
Differential current detection

Unit 201 Fundamentals of electronics and avionics

Outcome 5 Understand aircraft cabling tasks

Assessment Criteria

The learner can:

1. explain the use of crimping tools to terminate cables
2. explain construction processes for aircraft cable looms
3. describe how aircraft cables are identified using the ATA 100 system.

Range/Scope/Unit content

List 1

Use of a range of terminations and crimp tools eg:
Ring tongue terminals
Splices
Miniature connectors
Standard connectors
Testing crimp joints

List 2

General principles and methods using representative aircraft cable and components including:
Different sizes of cable
Different types of cable
Signal and power
Different types of loom tie
Inspection
Repair and maintenance
Standards of cleanliness

List 3

Marking systems eg: ATA100
Marking materials eg:
Ink
Sleeves
Stamping
For a range of cables eg:
Screened
Co-axial
High tension.

Unit 201 Fundamentals of electronics and avionics

Outcome 6 Understand aircraft power supplies

Assessment Criteria

The learner can:

1. describe aircraft battery systems
2. describe the layout of a generic multi-engine electrical power distribution system
3. describe components of an aircraft electrical power distribution system
4. describe the main categories of aircraft electrical-powered services
5. explain how aircraft electrical power is maintained in the event of emergencies
6. explain the sequence of connection and disconnection of aircraft ground/external electrical power
7. describe the standard dc and ac ground power connectors.

Range/Scope/Unit content

List 1

Block diagram

Including the purpose of each component

List 2

Block diagram

Including the purpose of each component

List 3

Generator

Constant speed drive unit

Main battery

Emergency battery

Rotary and static inverters

Transformer rectifier units

Generator control unit

Bus tie relay

Generator control relay

Battery isolation switch

RCCB (Reverse Current Circuit Breaker)

List 4

Vital services

Essential services

Non-essential services

List 5
Using:
Standby generators
Duplication of systems
Batteries
Emergency batteries
Ram air turbines
Transformer rectifier units
Static inverters
Auxiliary power unit

List 6
Engine(s) running, pre/post taxi
DC battery trolley
Ground maintenance
Petrol/diesel power set
Electric/electric power set

List 7
DC and AC connectors
Position and purpose of each pin.

Unit 201 Fundamentals of electronics and avionics

Outcome 7 Understand aircraft flight instruments and lighting systems

Assessment Criteria

The learner can:

1. explain the operation of pitot-static instruments
2. explain gyroscopic motion
3. explain the operation of gyroscopic flight instruments
4. compare the operation of direct and remote reading compasses
5. describe the layout and operation of aircraft stall warning systems
6. describe the layout and operation of the three main aircraft lighting systems.

Range/Scope/Unit content

List 1

Altimeter
Airspeed indicator
Vertical speed indicator
Mach meter

List 2

Qualitative explanation
Define related terms including:
Degrees of freedom
Rigidity
Precession
Gimballing
Topple

List 3

Principles and purpose of:
Artificial horizon
Attitude indicator
Direction indicator
Turn and slip indicator

List 4

Function, purpose and components of eg:
Emergency magnetic compass
Detector unit
Compass computer
Compass indicator

List 5
Typical arrangement and operation of eg:
Sensors
Warning devices

List 6
External: navigation, landing, taxiing, ice
Internal: cabin, cockpit, cargo
Emergency

Unit 201 Fundamentals of electronics and avionics

Outcome 8 Understand digital aircraft control and monitoring systems

Assessment Criteria

The learner can:

1. explain types of electrical signal
2. explain computer terminology
3. explain the purpose of a range of aircraft computer hardware
4. describe the main features of aircraft auto-flight control systems
5. explain radio signals
6. describe aircraft communication systems
7. describe the airborne navigation aids
8. explain the term 'databus'
9. describe aircraft electronic instrument systems
10. describe safety precautions when working on aircraft avionic equipment
11. describe aircraft onboard maintenance systems.

Range/Scope/Unit content

List 1

Analogue and digital

Simple explanation using sketched wave-forms

List 2

Commonly used terminology eg:

- Bit
- Byte
- Software
- Hardware
- CPU
- Chip

Memory:

- RAM
- ROM
- PROM
- Hard Drive

List 3

Input devices

Output devices

Microprocessor and interface devices

Visual display

Storage devices

List 4

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

List 5

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

List 6

Typical layout and operation of:
VHF
UHF
HF
Intercom
Satcom

List 7

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

List 8

Simple explanation including aircraft applications
Overview of databus types and designations

List 9

Layout and operation of a typical system eg:
Electronic Flight Instrument System (EFIS)
Engine Indicating and Crew Alerting System (EICAS)
Electronic Centralised Aircraft Monitoring (ECAM)
Automatic Flight Control System (ACS)

List 10

Eg:
ESD protection
Manual handling
Power management
Working at height

List 11

Typical layout, components and information outputs for a maintenance system eg:
Simple explanation of main monitoring areas and information output
Standard for OMS is ARINC 624

Unit 201 Fundamentals of electronics and avionics

Notes for guidance

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 3 – Electrical Fundamentals for the EASA Category A licence. It also contains parts of the B category requirements for other relevant modules.

The unit is intended to give a broad understanding of electrical and avionics systems in preparation for studying units 019, 020 and 021 of this qualification.

This unit contains the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 3 A Category and for parts of B Category modules The equivalent EASA knowledge level indicators for each of the above outcomes - required for the A Category items - 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 (Module 3)
Outcome 2: EASA Level 1 (Module 3)
Outcome 3: EASA Level 1 (Module 3)
Outcome 4: EASA Level 3 (Module 7.7 – B1 & B2)
Outcome 5: EASA Level 3 (Module 7.7 – B1 & B2)
Outcome 6: EASA Level 3 (Module 13.5 – B2 only)
Outcome 7: EASA Level 2 (Module 11.5 – B1 only)
Outcome 8: EASA Level 3 (Module 11.5 – B1 only)

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

Unit 202 Military policy and regulation in aviation

Level: 3
Credit value: 4
UAN: L/503/0959

Unit aim

This unit aims to give a working knowledge of military aviation policy and regulation and how aircraft maintenance records are created and archived.

Learning outcomes

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

1. understand military aviation policy
2. understand military aviation documentation
3. be able to create and maintain military aircraft maintenance documentation.

Guided learning hours

It is recommended that **30** 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 001, 002 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:

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

Assessment and grading

This unit will be assessed by:

- an assessment covering practical skills and underpinning knowledge.

Unit 202 Military policy and regulation in aviation

Outcome 1 Understand military aviation policy

Assessment Criteria

The learner can:

1. describe the principal sources of military aviation policy
2. explain the responsibility of maintenance personnel towards local orders and procedures
3. describe the function of military organisational manuals in aircraft maintenance
4. explain the significance of signatures on aircraft maintenance documents
5. explain the levels of personal authority in military aircraft maintenance.

Range/Scope/Unit content

List 1

Eg:
Military Aviation Authority
JAP 100A (Military Aviation Engineering Policy & Regulations)
Current Single Service Aviation Engineering Orders and Procedures

List 2

Eg:
Any Local Military Aviation Engineering Orders

List 3

Eg:
AP 33376 (Trade Structure of the Royal Air Force)
Catalogue of Army Qualifications (CATAQ)
B.R. 3 (Naval Personnel Management)

List 4

Eg:
Legally binding signature
Implications of false declaration

List 5

Eg:
Signing for work
Supervisory
Individual authorisation
Acceptable Deferred Faults Log
Limitations Log
Authority levels (JAP 100A).

Unit 202 Military policy and regulation in aviation

Outcome 2 Understand military aviation documentation

Assessment Criteria

The learner can:

1. describe the content of military aircraft maintenance publications
2. explain the contents of the MOD Form 700 series
3. explain the independent check regulations
4. explain electronic data recording for maintenance purposes
5. explain terminology used in the Aircraft Safety and Servicing Notes
6. explain the purpose and typical content of maintenance instructions.

Range/Scope/Unit content

List 1

Eg:

System of numbering of Air Publications

Main titles common to all aircraft

Examples of main titles (eg: Power plant, Undercarriage, Communications etc.)

List 2

Eg:

Description

Legal status

Sections

Information contained in the folder

List 3

Purpose

From JAP100A-01 Chapter 6.10

List 4

a typical system of Purpose

What it records

How information is organised

Security provisions and procedures

How information is inserted

Legal status of entries

Password

Data accuracy

List 5

As required from list in JAP 100A-01 chapter 0.4

List 6

Purpose

From JAP 100A-01

Eg

- Special Technical Instructions (STI)
- Servicing Instructions (SI)
- Urgent Technical Instructions (UTI)
- Routine Technical Instructions (RTI)
- Modifications
- Special Trial Fits (STF)

Unit 202 Military policy and regulation in aviation

Outcome 3 Be able to create and maintain typical military aircraft maintenance documentation

Assessment Criteria

The learner can:

1. extract information from engineering Air Publications for given maintenance tasks
2. carry out all actions required to report a fault on an aircraft that renders it 'unserviceable'
3. complete all required documentation following an aircraft repair task
4. complete all required documentation following scheduled maintenance tasks
5. complete documentation for equipment or components removed from an aircraft.

Range/Scope/Unit content

List 1

For relevant trade tasks eg:

Diagnosis

Repair/replacement

Adjustment

Post-repair testing

List 2

Eg

MOD F700 series forms

Electronic data recording

List 3

Eg

MOD F700 series forms

Electronic data recording

List 4

Eg

MOD F700 series forms

Electronic data recording

List 5

Using relevant equipment conditioning documentation

Unit 202 Military policy and regulation in aviation

Notes for guidance

This unit has been produced to meet military aviation training requirements.

On completion of this unit the learner will be able to show a comprehensive knowledge of the aviation policy and regulation relating to the servicing of military aircraft.

Assessment is to be designed to demonstrate underpinning knowledge and use of relevant documentation.

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Level: **3**
Credit value: **4**
UAN: **D/503/0965**

Unit aim

This unit aims to give the learner a working knowledge of aircraft aerodynamics and control to as a basis for further study. It contains syllabi for the EASA 2042/2003 part 66 Basic Knowledge Requirements Module 8 and for part of Module 11A (11.1 only).

Learning outcomes

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

1. know the properties of the Earth's atmosphere
2. understand the nature of airflow around aerodynamic bodies
3. understand the characteristics of the basic wing plan forms
4. understand the principles of aircraft control
5. understand the principles of aircraft stability
6. understand the purpose and operation of secondary flying control surfaces
7. understand methods of balancing and trimming control surfaces
8. understand the basic theory of high speed flight

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 3 NOS Units 140, 154 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
- Information and Communication Technology
- 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 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 1 Know the basic properties of the Earth's atmosphere

Assessment Criteria

The learner can:

1. describe the basic nature and composition of the Earth's atmosphere
2. describe the main layers of the Earth's atmosphere
3. solve problems using the basic gas laws
4. describe the use of the International Standard Atmosphere (ISA) in aviation.

Range/Scope/Unit content

List 1

Air composition
Temperature
Pressure
Density
Position on the Earth's surface
Climatic conditions

List 2

Including the region of constant temperature (with altitude)

List 3

Boyle's Law
Charles' Law
Gay-Lussac's Law
Combined Gas Law

List 4

Quoting values at sea level in SI and Imperial units:
Pressure: psi, Nm^{-2}, bar, millibar, hectopascal
Density: kgm^{-3}
Temperature: °C, Kelvin, °F

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 2 Understand the nature of airflow around aerodynamic bodies

Assessment Criteria

The learner can:

1. describe the main properties of airflow
2. describe how air flows around an aerodynamic body
3. explain how an aerofoil stalls
4. explain the effect of a stalled aerofoil on an aircraft in flight
5. describe the main characteristics of symmetrical and cambered aerofoils
6. describe how the airflow around aerofoils changes with angle of attack and velocity
7. explain how lift and drag affect aircraft performance
8. use standard equations to explain how lift and drag can vary
9. explain how a high lift device alters the flow characteristics of an aerofoil
10. explain how the total drag of an aircraft is generated
11. describe common methods of drag reduction.

Range/Scope/Unit content

List 1

Eg:
Compressible
Viscosity
Changed by temperature, solid objects etc.

List 2

Related to different types of flow including:
Laminar, turbulent (boundary layer)
Free stream
Up and down wash
Vortices
Features including:
Stagnation point/region
Transition and separation points

List 3

Mechanism in terms of airflow

List 4

Effect in terms of passage through the air and degree of control available
Eg: level stall, spin.

List 5
Related to 2 and including:
Chord line
Mean camber line
Angle of attack
Angle of incidence
Fineness ratio
Thickness to chord ratio (percentage)

List 6
With reference to Bernoulli's principle
Including resulting static pressure changes following:
Changes in angle of attack, including around the stall
Velocity changes

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

List 7
Simple explanation

List 8
Including, for both cambered and symmetrical aerofoils:
How the following change with angle of attack:
Lift coefficient
Drag coefficient
Lift/drag ratio

List 9
Eg:
Airflow separation
Changes in lift and drag coefficients

List 10
Including explanations of:
Induced drag
Pressure or form drag
Skin friction
Interference drag
Parasite drag

List 11
Eg:
Polished surfaces
Fairings
Special materials
Aerodynamic shape

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 3 Understand the characteristics of the basic wing planforms

Assessment Criteria

The learner can:

1. describe the basic wing planforms and their typical applications
2. apply simple dimensional calculations for each basic wing planform
3. describe the airflow over each basic wing planform
4. describe the effect of ice, snow and frost build-up on the performance of aerofoils.

Range/Scope/Unit content

List 1

Rectangular
Tapered
Swept
Delta

List 2

Span
Aspect ratio
Taper ratio
Gross wing area
Wash in
Wash out

List 3

Using simple diagrams:
In normal flight
At or near the stall

List 4

Eg:
Change of shape
Increase in weight
Variation in thickness

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 4 Understand the principles of aircraft control

Assessment Criteria

The learner can:

1. explain the relationship between the four main forces acting on an aircraft
2. explain the meaning of 'aircraft control'
3. describe the operation and effect of the primary aircraft control surfaces
4. explain the need for instinctive control
5. describe typical aircraft performance in different phases of flight
6. describe how turning flight is related to the stall
7. describe how turning flight changes the loading on an airframe.

Range/Scope/Unit content

List 1

Lift
Drag
Thrust
Weight
Balancing effect of the tailplane

List 2

Any accepted definition

List 3

Elevator
Aileron
Rudder

List 4

Define instinctive control
Describe the relationship between:
Control movements made by the pilot
Control surface movement
Movement of the aircraft

List 5

Straight and level flight
Climb
Descent
Glide
Turn

List 6
Aerodynamic explanation
Spins

List 7
Simple explanation including the effect on structural defects.

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 5 Understand the principles of aircraft stability

Assessment Criteria

The learner can:

1. explain the nature of aircraft flight stability
2. relate the three aircraft axes to different types of stability
3. explain the differences between statically stable, unstable and neutral aircraft
4. describe major components on an aircraft that affect stability in flight
5. describe typical methods of enhancing stability.

Range/Scope/Unit content

List 1

Eg:
Active stability
Passive stability

List 2

Eg:
Pitch stability eg:
Short period pitch oscillation
Long period pitch oscillations (Phugoid)
Lateral stability eg:
Dutch roll
Directional stability eg:
Weathercocking

List 3

Definitions and examples of:
Static or positive stability
Negative stability (unstable)
Zero stability (neutral)

List 4

Eg:
Position and size of vertical stabiliser(s)
Shape and mounting of the wings (eg: anhedral/dihedral, aspect ratio etc.)
Design of the tailplane

List 5

Eg:
Adjusting the centre of gravity
Design of lifting and control surfaces (eg: wings, canards, tailplane etc.)

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 6 Understand the purpose and operation of secondary flying control surfaces

Assessment Criteria

The learner can:

1. describe secondary effects of roll and yaw and methods of overcoming them
2. describe the arrangement and operation of alternative and combined flying controls
3. describe the general flow characteristics of high lift devices
4. compare the performance of trailing edge high-lift devices
5. describe the aerodynamic problems caused by asymmetric flap operation
6. compare the performance of leading edge high-lift devices
7. explain the purpose and operation of stall strips/wedges
8. describe methods of boundary layer control
9. compare the operation of high drag devices.

Range/Scope/Unit content

List 1

Description in terms of airflow over control surfaces
Main issue is adverse yaw
Explain the effect of adverse yaw on roll rate
Ways of counteracting averse yaw eg:
Differential ailerons
Frise ailerons
Roll spoilers
Explain the secondary roll effect of applying rudder
Explain this is worse in V-tailed aircraft
Co-ordinated use of rudder and aileron

List 2

Arrangement, operation and reasons for:
Spoilers
All-moving tailplane (slab/stabilator)
Tailerons
Canards
Elevons
Ruddervators
Flaperons

List 3
Using the example of eg: a trailing edge flap
Explanation to centre on:
Airflow changes on deployment eg:
Change in lift and drag coefficients
Airflow separation

List 4
Advantages, disadvantages with respect to aerodynamic effectiveness and operation:
Plain flap
Split flap
Slotted flap
Fowler flap

List 5
Explanation of asymmetric flap and how it happens
Description of the effect on aircraft attitude

List 6
Advantages, disadvantages with respect to aerodynamic effectiveness and operation:
Krueger flap
Leading edge droop
Slots
Slats

List 7
Reason
Position
How they operate

List 8
Eg:
Blown air
Suction
Wing fences

List 9
Including limitations in flight and on the ground
Spoilers
Lift dumpers
Speed brakes

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 7 Understand methods of balancing and trimming control surfaces

Assessment Criteria

The learner can:

1. explain the effects of airspeed on flying controls
2. explain the need for aerodynamic balancing
3. explain the operation of control surface trimming devices
4. describe control surface flutter
5. explain mass balance

Range/Scope/Unit content

List 1

Eg: Increased airspeed = greater force on controls
Eg: Increased airspeed = smaller controlled movements required

List 2

Eg: Counter-acting increased force from increased airspeed

List 3

Include reasons for trimming devices
Balance tab
Anti-balance tab
Spring tab
Trim tab
Servo tab
Variable incidence tailplane

List 4

Related to airspeed
Effects of vibration on:
Pilot
Airframe
Control linkage

List 5

Why is it done and how is it achieved?
Include explanations of:
Out of balance force
Forward and rear limits
Centre of gravity

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Outcome 8 Understand the basic theory of high speed flight

Assessment Criteria

The learner can:

1. explain the significance of 'speed of sound' to an aircraft in flight
2. explain terms related to high speed flight
3. explain 'Mach number' and 'critical Mach number'
4. describe the formation and development of shock waves
5. explain terms related to transonic flight
6. explain methods of overcoming problems during transonic flight
7. describe the factors affecting airflow through an intake of a high speed aircraft.

Range/Scope/Unit content

List 1

Define 'speed of sound'

Include variation of speed of sound with atmospheric conditions eg:

Altitude

Air density

Temperature

List 2

Subsonic flight

Transonic flight

Supersonic flight

List 3

Including their significance to aircraft flight

List 4

Including:

How and when they are formed

How and why they develop

Their properties

Effect on the airflow eg:

Movement of the centre of pressure

List 5
Compressibility
Buffet
Shockwave formation
Spanwise flow
Shock stall
Boundary layer flow separation
Control ineffectiveness
Instability

List 6
Swept wings
Wing fences
Saw-tooth leading edges
Notched leading edges
Vortex generators
Area rule
Spoilers
Slab tailplane/stabilators
Active stability devices

List 7
Intakes eg:
Engine intakes
Air scoops
Problems with high sped and supersonic air eg:
Shock wave
Air too fast for engine intake
Solutions eg:
Variable geometry intakes

Unit 203 Aircraft aerodynamics and control in fixed-wing aircraft

Notes for guidance

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

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

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

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

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

Unit 208 Maintaining aircraft electrical cables

Level: 3
Credit value: 10
UAN: J/503/1107

Unit aim

The aim of this unit is to give the learner a detailed understanding of the process of testing electrical and avionics equipment and maintaining aircraft wiring. It contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 7 – Maintenance Principles for the B2 Category licence.

Learning outcomes

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

1. know workshop safety, tool selection and tool control
2. understand standards for engineering drawings in the aviation industry
3. know procedures and precautions for aircraft handling tasks
4. understand inspection and quality assurance procedures in aircraft maintenance
5. know types of aircraft electrical cable
6. know how aircraft cable is prepared and terminated
7. know how aircraft cable is installed and maintained
8. understand the electrical bonding of aircraft structure
9. be able to use electrical wiring maintenance and testing techniques.

Guided learning hours

It is recommended that **80** 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 122, 131 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
- Problem Solving
- Working with Others

Assessment and grading

This unit will be assessed by:

- an assignment covering practical skills and underpinning knowledge.

Unit 208 Maintaining aircraft electrical cables

Outcome 1 Know workshop safety, tool selection and tool control

Assessment Criteria

The learner can:

1. describe fire precautions and procedures in workshop environments
2. describe compressed gas procedures in workshop environments
3. describe oil and chemical procedures in workshop environments
4. describe safe working procedures in workshop environments
5. describe tool and material control procedures in workshop environments
6. describe tools used in aircraft electrical installation work
7. describe standards of electrical and avionic work
8. describe the system of fits and clearances used in aircraft engineering.

Range/Scope/Unit content

List 1

Knowledge of precautions in both training environment and typical workplace environments such as:

Composite production, wiring shops, aircraft major component assembly, (fuselage, wings etc), clean rooms

Demonstrate knowledge of emergency procedures eg: tackling small fires, evacuation

List 2

Knowledge of precautions in both training environment and typical workplace environments such as:

Composite production, wiring shops, aircraft major component assembly, (fuselage, wings etc), clean rooms, confined spaces

Demonstrate knowledge of emergency procedures eg: minor incidents, evacuation

List 3

Knowledge of precautions in both training environment and typical workplace environments such as:

Composite production, wiring shops, aircraft major component assembly, (fuselage, wings etc), clean rooms, confined spaces

Demonstrate knowledge of emergency procedures eg: tackling small spillages, evacuation

List 4

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

List 5

Tools including: shadow boards, personal tool kits, automatic tool check, tool inspection, renewal and calibration, personal discipline, responsibility to report losses and damage

Materials including: ordering and issue of large (eg sheet material) and small (eg: nuts, bolts, washers) items, responsibility to check before use

List 6

How they are used and maintained Inspection, calibration and care of eg: strippers, crimp tools (mechanical and hydraulic), cutters, wire gauges, go/no-go gauges, heat shrink guns, marking and sleeving equipment, wrapping tools, torque drivers

List 7

Correct methods of work, dimensions, tolerances, allowances

List 8

With respect to electrical and avionics equipment, an overview of:

Drill sizes for bolt holes, classes of fits

Common system of fits and clearances

Schedule of fits and clearances for aircraft equipment

Standard methods of checking shafts, bearings and other common parts (eg in generators and motors).

Unit 208 Maintaining aircraft electrical cables

Outcome 2 Understand standards for engineering drawings in the aviation industry

Assessment Criteria

The learner can:

1. describe the main types of aircraft engineering drawings
2. describe how drawings are uniquely identified and maintained up to date
3. describe features of other common drawing standards used in the aviation industry
4. explain the use of wiring diagrams, tables and other schematic diagrams used in aircraft electrical and avionics systems.

Range/Scope/Unit content

List 1

The features and uses of each type using information from

CAA CAP562 Leaflet 2-1or equivalent documents

Including BS8888 general symbols and conventions, local approved standards where applicable (detailed where applicable to electrical systems, overview of important other items)

List 2

Including information in CAA CAP562 Leaflet 2-1or equivalent documents

List 3

Overview of eg: ISO, Mil, AN, MS, NAS, ATA Spec100

List 4

Including presentation methods: paper, computer, microfilm/fiche

Standards eg civil or military.

Unit 208 Maintaining aircraft electrical cables

Outcome 3 Know procedures and precautions for aircraft handling tasks

Assessment Criteria

The learner can:

1. describe procedures for aircraft towing
2. describe procedures for jacking, chocking and securing aircraft
3. describe procedures for storing aircraft
4. describe procedures for aircraft refuelling and defueling
5. describe procedures ground de-icing and anti-icing aircraft
6. describe procedures for using aircraft ground services
7. describe effects of environmental conditions on aircraft handling and operation.

Range/Scope/Unit content

List 1

General knowledge of practice and theory

Including safety precautions

List 2

General knowledge of practice and theory

Including safety precautions

List 3

General knowledge of practice and theory including anti-deterioration maintenance

Including safety precautions

List 4

General knowledge of practice and theory especially bonding and other safety precautions Open line and pressure refuelling

List 5

General knowledge of practice and theory including difference between anti-icing and de-icing and the substances used

Including safety precautions

List 6

Electrical, hydraulic and pneumatic ground supplies

Detail of typical procedures and precautions for each

List 7

General knowledge of practice and theory eg:

Heavy rain

Ice and snow

High winds

Unit 208 Maintaining aircraft electrical cables

Outcome 4 Understand inspection and quality assurance procedures in aircraft manufacture

Assessment Criteria

The learner can:

1. describe the organisation of quality departments in aircraft manufacturing organisations
2. describe stores facilities in aircraft manufacturing organisations
3. describe defects that may be found during inspection of aircraft and associated equipment
4. describe inspection techniques used to find defects in aircraft
5. describe trouble-shooting techniques
6. describe assembly and disassembly techniques
7. explain the principles of aircraft modification
8. explain the life-limitation of aircraft components
9. describe how to inspect aircraft following unusual events
10. explain the principles of aircraft Centre of Gravity calculations.

Range/Scope/Unit content

List 1

Including: compliance, auditing, inspection, training

List 2

General knowledge of function and responsibilities including: procurement and control of: Tools

Spares and materials

Bonded store

Quarantine

List 3

Overview of: structural defects (eg: cracks, skin damage, corrosion), mechanical system defects (eg: broken or chafed pipes, fluid leaks, signs of overheating)

Detail of: electrical/avionic equipment damage (external, signs of overheating, damaged cooling ducts), wiring defects (eg: wrongly routed, chafed, overheated cable or terminations, impact or chemical damage, corrosion, ageing, wrongly labelled), bonding defects (eg: corrosion, poorly sited, incorrect fasteners – type or material)

List 4

Overview of techniques for mechanical inspection eg: NDT (x-ray, ultrasonic, visual, borescope); destructive eg: removal of skin; functional and performance testing

Detail of techniques for electrical, avionics and wiring eg: visual inspection, electrical testing (programmable loom testing, TDR, insulation testing), functional and performance testing)

List 5

Eg: half-split, signal injection, input/output, functional and diagnostic test, self test/check

List 6

Emphasis on electrical wiring and equipment eg: connector blocks, panels, connector blocks, multi-way connectors

Techniques eg: use of correct tools; anti-seize fluids; care of loose items; marking items for re-assembly; replacing single-use, lifed and worn items, protection of re-assembled items

List 7

Using an appropriate regulatory framework eg: EASA, CAA, Mil:

Typical reasons for modifications

Design and approval procedure – overview

Modification procedures – typical electrical/avionics

Recording and marking modified items

List 8

Reasons for life-limitation

Control of lifed items

List 9

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

List 10

General knowledge of the reasons for the calculations eg:

Effects on aircraft performance of C of G position, safe limits

How the measurements and calculations are done

Use of the relevant documents.

Unit 208 Maintaining aircraft electrical cables

Outcome 5 Know types of aircraft electrical cable, its properties and uses

Assessment Criteria

The learner can:

1. describe electrical and environmental challenges to aircraft electrical wiring
2. describe cable types used in aircraft electrical power supply systems
3. describe cable types used in aircraft digital systems
4. describe cable types used in aircraft communication systems
5. describe fibre-optic cable used in aircraft systems.

Range/Scope/Unit content

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

List 1

Eg: overheating due to excessive current, poor cooling, poor connections, chemical contamination, deterioration and damage to insulation, water ingress/absorption, mechanical damage due to abrasion, poor routing and excessive pull-through forces

List 2

Including: insulation and conductor materials, size and capacity, main manufacturers and users

Physical properties including mechanical and insulation performance, relative safety in challenging environments, uses in specific applications

List 3

Including: insulation and conductor materials, size and capacity, main manufacturers and users

Physical properties including mechanical and insulation performance, relative safety in challenging environments, uses in specific applications

List 4

Including: insulation and conductor materials, size and capacity, main manufacturers and users

Physical properties including mechanical and insulation performance, relative safety in challenging environments, uses in specific applications

List 5

Including: materials, construction, size and signal capacity

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

Unit 208 Maintaining aircraft electrical cables

Outcome 6 Know how aircraft cable is prepared and terminated

Assessment Criteria

The learner can:

1. describe the preparation of typical aircraft cable for crimping
2. describe the preparation of typical aircraft cable for soldering
3. describe the termination of typical aircraft cable by crimping
4. describe the termination of typical aircraft cable by soldering
5. describe the preparation and assembly of a range of electrical connectors
6. describe the termination of aircraft fibre optic cable.

Range/Scope/Unit content

List 1

Use of a range of preparation tools

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

List 2

Use of a range of preparation tools

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

List 3

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

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

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

List 4

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

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

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

List 5

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

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

Explain the safety precautions for typical potting compound

List 6

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

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

Unit 208 Maintaining aircraft electrical cables

Outcome 7 Know how aircraft cable is installed and maintained

Assessment Criteria

The learner can:

1. describe effects on individual cables when bunched together in wiring looms
2. describe techniques used in the manufacture of aircraft cable assemblies
3. describe how aircraft wiring is installed and secured in place
4. describe how aircraft wiring is inspected and maintained in-service
5. describe techniques used in the repair of aircraft cable assemblies.

Range/Scope/Unit content

List 1

Eg: reduced heat dissipation, interacting fields, creating capacitive interference between power and signals, chemical interaction between insulation materials

Methods of eliminating or minimising adverse effects eg: screening, separation of cable and signal types

List 2

Eg: wrapping, lacing, sleeving, potting, crimping, profiling, strain relief, testing of crimp joints

List 3

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

Methods of protection and support for aircraft wiring assemblies

Carry out typical installation work in a real or simulated environment

List 4

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

Inspect a typical installation and report findings

Describe repair criteria and methods

List 5

Describe typical regulatory requirements for cable repair eg: CAA, EASA, Mil

Repair typical defects by in-line crimp and wire replacement

Unit 208 Maintaining aircraft electrical cables

Outcome 8 Understand the electrical bonding of aircraft structure

Assessment Criteria

The learner can:

1. explain why aircraft structure needs to be electrically bonded
2. describe methods used to electrically bond metal airframe structure
3. describe methods used to electrically bond composite aircraft structure
4. describe methods used to test and inspect electrical bonding.

Range/Scope/Unit content

List 1

Eg: prevention of static build-up and arcing (eg: in fuel tanks), reduction of signal noise, lightning protection, provide earthing points for refuelling, ground power etc.

List 2

Including: locations, accessibility, fasteners, bonding straps, materials, protection of bonding points

List 3

Including: locations, accessibility, fasteners, bonding straps, materials, bonding of external antennae (eg: use of backplanes), protection of bonding points

List 4

Inspection including: broken or damaged bonding straps, corrosion of terminations and surrounding areas, potential for damage of newly installed bonding, typical bonding resistance values

Testing including: intrinsically safe test equipment, dangerous environments such as fuel tanks, removal of electrical power, disconnection of sensitive equipment.

Unit 208 Maintaining aircraft electrical cables

Outcome 9 Be able to use electrical wiring and testing techniques

Assessment Criteria

The learner can:

1. demonstrate workplace emergency procedures
2. demonstrate workshop procedures
3. demonstrate how aircraft cable is prepared and terminated
4. demonstrate how aircraft wiring is installed and secured in place
5. interpret wiring diagrams, tables and other schematic diagrams used in aircraft electrical and avionics systems
6. demonstrate techniques used in the manufacture of aircraft cable assemblies
7. inspect aircraft cable looms
8. demonstrate fault finding techniques
9. demonstrate techniques used in the repair of aircraft cable assemblies
10. test wiring installations using approved test equipment
11. install and test electrical bonding on structural components
12. test avionic equipment.

Range/Scope/Unit content

List 1

Simulation/walk-through of eg:
Fire evacuation
Fuel, oil, chemical spillage
Electrical emergency

List 2

Safety
Tool selection
Tool control
Materials and spares control

List 3

Eg:
Crimping (cutting, stripping, fitting terminations)
Soldering (cutting, stripping, fitting terminations)
Fibre Optic cables and terminations (cutting, polishing, fitting connectors)
Preparation and assembly of a range of electrical connectors eg:
HT
Power
Signal
Data

List 4

Eg:
Troughs
Conduits
Cable ties

List 5

Conforming to one or more standards

Military or Civil

List 6

Construct sample cable looms using a range of cable types, terminations and connectors eg:

Electrical

Signal

Data

Communications

List 7

Eg:

Visual

Testing

List 8

Using standard fault finding methods and equipment eg:

Wiring faults

Basic electrical system faults

Basic avionic system faults

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

List 9

Eg:

In-line crimps

Replacement of one cable in a bundle

List 10

Eg:

Continuity tester

Insulation tester

Programmable loom tester

List 11

Demonstrate the electrical bonding of aircraft metal or composite structure

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

Prepare surfaces, holes etc

Install bonding and apply protective coating

List 12

On or off aircraft

Avionic or electrical system or component eg:

Altimeter, ASI, VSI

Transformer/rectifier unit

Lighting systems

Unit 208 Maintaining aircraft electrical cables

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

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

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

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

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

Unit 209 Electronics in aircraft

Level: **3**
Credit value: **9**
UAN: **J/503/1110**

Unit aim

This unit aims to give the learner a comprehensive knowledge of electrical and electronic principles in order to understand complex aircraft electrical and electronic systems.

Learning outcomes

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

1. understand electrical and electronic components
2. understand transformers, filters and integrated circuits
3. understand printed circuit boards
4. understand servomechanisms
5. understand DC circuits and components
6. understand AC circuits and components
7. understand DC generators and motors
8. understand AC generators and motor
9. be able to construct and test working electronic circuits

Guided learning hours

It is recommended that **70** 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 132, 214 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
- Problem Solving

Assessment and grading

This unit will be assessed by:

- an assignment covering practical skills and underpinning knowledge.

Unit 209 Electronics in aircraft

Outcome 1 Understand electrical and electronic components

Assessment Criteria

The learner can:

1. describe the properties of resistors
2. describe the properties of capacitors
3. explain the fundamental laws of magnetism
4. explain the fundamental principles of electromagnetic induction
5. describe the properties of inductors
6. describe the properties of semi-conductor devices.

Range/Scope/Unit content

List 1

Including: variable resistors, thermistors, carbon, wire-wound,

How they are constructed

Operating principles including temperature coefficients, conductance, tolerances, limits,

Markings and values: colour coding, preferred values, wattage ratings, specific resistance

How they are used in circuits; series, parallel, series-parallel including calculations using Ohms and Kirchhoff's Laws

Construction of a Wheatstone bridge

List 2

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

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

Markings and values: colour coding

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

List 3

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

Sufficient to understand inductors and transformers

List 4

Sufficient to understand inductors and transformers:

List 5

How they are constructed

Operating principles

Markings and values

How they are used in circuits

List 6

Including:

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

How they are constructed

Operating principles

Markings and values

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

How they are tested

Vulnerabilities, eg: ESD, heat

Unit 209 Electronics in aircraft

Outcome 2 Understand transformers, filters and integrated circuits

Assessment Criteria

The learner can:

1. describe how transformers are constructed
2. explain the operation of transformers
3. use transformer theory to solve simple design problems
4. describe simple filter circuits
5. use filter theory to solve design problems
6. describe how integrated circuits are constructed
7. explain the different types of integrated circuit.

Range/Scope/Unit content

List 1

Core materials and shapes

Windings – materials, primary and secondary coils, turns ratio, voltage tapping

List 2

Including:

Frequency range and the effects of operating close to or outside limits

Power transfer

Efficiency,

Single and three-phase calculations

Auto transformers

How outputs can be adjusted to suit specific circuits

List 3

Eg: power supplies to specific equipment

List 4

High-pass

Low-pass

Band-pass

Band stop

List 5

Simple problems eg: isolation of power supplies from sensitive signal sources

List 6

Construction: overview of materials, construction methods and conditions, scale of integration

List 7
Including:
Operational amplifier
Microprocessor
Mixed signal
EPROM
Logic circuits
Vulnerabilities eg: ESD, heat, extreme cold, EMP, excess voltages.

Unit 209 Electronics in aircraft
Outcome 3 Understand printed circuit boards

Assessment Criteria

The learner can:

1. explain the reason for using printed circuit boards
2. describe the construction of printed circuit boards
3. describe ways in which components can be attached to printed circuit boards
4. describe typical damage and faults to be found on printed circuit boards
5. describe applications of printed circuit boards

Range/Scope/Unit content

List 1

Eg: generally cheap and easy to produce, repeatable, reliable

List 2

Overview eg:
Single and double sided
Encapsulated
Dielectric and track materials
Construction methods:
Patterning
Lamination
Drilling
Solder resist etc

List 3

Eg: hand soldering, wave soldering, surface mount

List 4

Eg: dry joint, cracked dielectric, broken or overheated track

List 5

In aircraft equipment

Unit 209 Electronics in aircraft

Outcome 4 Understand servomechanisms

Assessment Criteria

The learner can:

1. explain terms relating to servomechanisms
2. describe servomechanisms
3. describe representative aircraft control systems
4. describe representative aircraft indication systems.

Range/Scope/Unit content

List 1

Define: servomechanism,

Explain: open loop, closed loop, feedback (positive and negative), follow-up, analogue, transducer, null, damping, dead band, hunting

Describe typical faults, effect of reversing synchro leads

List 2

Resolvers, differential, control and torque, E&I transformers, inductance and capacitance transmitters, synchronous transmitters

List 3

Eg: flight control systems, air conditioning and pressurisation, engine controls

List 4

Eg: engine, electrical power, flap position, cabin conditioning

Unit 209 Electronics in aircraft

Outcome 5 Understand DC circuits and components

Assessment Criteria

The learner can:

1. explain basic electrical terms
2. explain the relationship between current, voltage and resistance
3. explain the significance of internal resistance in power supplies
4. explain Kirchhoff's Laws of current and voltage
5. explain how power is dissipated in DC circuits.

Range/Scope/Unit content

List 1

Conductors, insulators, current, voltage, resistance, potential difference, electromotive force, conventional current flow, electron flow, conductance

List 2

Using Ohms Law calculations

List 3

Using worked examples

List 4

Using simple DC circuits

List 5

Power, work and energy

Dissipation of power by a resistor

Power formula

Calculations involving power, work and energy

Unit 209 Electronics in aircraft

Outcome 6 Understand AC circuits and components

Assessment Criteria

The learner can:

1. describe the operation of rectifiers
2. describe the effects of reservoir capacitors on output voltages
3. explain the need to reduce output voltage ripple
4. describe the relationship between voltage, current and power in AC circuits
5. explain how three-phase AC waveforms can be produced
6. use AC circuit theory to solve series and parallel network problems

Range/Scope/Unit content

List 1

Half-wave

Bi-phase full-wave

4 diode bridge

List 2

Eg: smoothing DC output voltage

List 3

Eg: reduce noise in audio amplifiers; eliminate errors in A-D convertors

List 4

Resistive, capacitive and inductive circuits

Phase, period, frequency, cycle, amplitude, peak-to-peak value, rms value, average value

By measurement or calculation

List 5

Using phasor diagrams only – no calculations required

List 6

Using resistive, capacitive and inductive circuits

Unit 209 Electronics in aircraft

Outcome 7 Understand DC generators and motors

Assessment Criteria

The learner can:

1. explain the magnetic principles used in motors and generators
2. explain how electromagnetic induction is used in motors and generators
3. explain the operation of series wound generators
4. explain the operation of shunt wound generators
5. explain the operation of DC compound generators
6. explain the requirements for operating DC generators in parallel
7. describe the operation of DC series wound motors
8. describe the operation and control of DC shunt wound motors
9. describe the operation of DC compound motors.

Range/Scope/Unit content

List 1

Electromagnets, magnetic fields, forces, field around a current-carrying conductor, magnetic shielding

Sufficient to understand generators and motors

List 2

Including:

Magneto-motive force, field strength, magnetic flux density, permeability, hysteresis loop, Retentivity, coercive force, reluctance, saturation point, eddy currents, Fleming's Left and Right hand Rules, storage of magnets

Sufficient to understand motors and generators

List 3

Sufficient to allow understanding of standard aircraft systems– include circuit diagrams

Eg: field and armature windings in series, output varies directly with load current, little use practically

List 4

Sufficient to allow understanding of standard aircraft systems– include circuit diagrams

Eg: field and armature windings in parallel, output varies inversely with load current

Typical aircraft applications

List 5

Sufficient to allow understanding of standard aircraft systems – include circuit diagrams

Eg: series and shunt field coils, outputs generally constant in normal operating range

Typical aircraft applications

List 6

Sufficient to allow understanding of standard aircraft systems

Eg: equalise voltages before paralleling

Typical aircraft applications

List 7

Sufficient to allow understanding of standard aircraft systems

Eg: generates a large torque, good low-speed operation, moves heavy loads slowly, light loads quickly

Typical aircraft applications

List 8

Sufficient to allow understanding of standard aircraft systems

Eg: good speed and torque control, decreased torque at higher speeds

Typical aircraft applications

List 9

Sufficient to allow understanding of standard aircraft systems

Eg: combines characteristics of series and shunt wound, greater torque than shunt motor, more constant speed with varying load

Typical aircraft applications.

Unit 209 Electronics in aircraft

Outcome 8 Describe the construction, purpose and function of typical AC generators and motors

Assessment Criteria

The learner can:

1. describe AC generators
2. explain the requirements for operating AC generators in parallel
3. describe AC induction motors
4. describe AC synchronous motors.

Range/Scope/Unit content

List 1

Principles of operation sufficient to allow understanding of standard aircraft systems eg:

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

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

Typical aircraft applications

List 2

Sufficient to allow understanding of standard aircraft systems eg:

Synchronisation prior to parallel connection

One generator at a time

Use of a synchroscope

Typical aircraft applications

List 3

Construction and operation sufficient to allow understanding of standard aircraft systems eg: rotor, stator

Squirrel cage rotor

Phase splitting (single-phase AC induction motor)

Typical aircraft applications

List 4

Construction and operation sufficient to allow understanding of standard aircraft systems eg: stator, rotor, windings, slip rings

The need for a starting device

Field excitation

Typical aircraft applications.

Unit 209 Electronics in aircraft

Outcome 9 Be able to construct and test working electronic circuits

Assessment Criteria

The learner can:

1. construct simple circuits to prove Ohm's and Kirchhoff's Laws
2. demonstrate the relationship between voltage, current and power in AC circuits
3. construct and test smoothed and stabilised power supplies.

Range/Scope/Unit content

List 1

Using a variety of components, from a circuit diagram, assembled and tested

List 2

Using a variety of components, from a circuit diagram, assembled and tested

Demonstrate AC waveforms

Measure a range of parameters (eg: phase, p-p and peak values)

Demonstrate the use of phasor representation of sinusoidal quantities

List 3

Using a variety of components, from a circuit diagram, assembled and tested

Demonstrate varying degrees of smoothing

Unit 209 Electronics in aircraft

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

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

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

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

Unit 210 Maintaining aircraft avionic systems

Level: 3
Credit value: 12
UAN: T/503/1216

Unit aim

This unit aims to give the learner a comprehensive understanding of aircraft electrical and avionic systems, applying basic principles previously learned. The unit has a fixed-wing context.

Learning outcomes

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

1. understand aircraft instrumentation and air data systems
2. understand fixed-wing flying control systems
3. understand aircraft power distribution systems
4. understand aircraft management, lighting and warning systems
5. understand aircraft engine electrical systems
6. understand aircraft electrical power sources
7. understand aircraft communication systems
8. understand aircraft navigation systems
9. be able to maintain aircraft avionic 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 Aeronautical Engineering Level 3 NOS Units 62-88.

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

Assessment and grading

This unit will be assessed by:

- an assignment covering practical skills and underpinning knowledge.

Unit 210 Maintaining aircraft avionic systems

Outcome 1 Understand aircraft instrumentation and air data systems

Assessment Criteria

The learner can:

1. explain the need for aircraft instrumentation
2. explain the operation of pitot-static systems
3. the operation of pitot-static system components
4. describe procedures for pitot-static system functional checks
5. describe stall warning and angle of attack indicating systems
6. explain how outputs are computed within an air data system
7. explain instrumentation system sensors
8. describe the layout of aircraft engine indication systems
9. explain test equipment for a range of indicating systems
10. describe gyroscopic primary flight instruments
11. explain flight data and cockpit voice recorders

Range/Scope/Unit content

List 1

Eg: in terms of: physiological limitations of a (human) pilot (unable to sense speed, height, altitude etc. accurately or safely), complexity of aircraft requires accurate data for display and to compute control signals

List 2

Define pitot and static pressure

Operation eg: outputs required, available quantities to measure, method of measurement of each, method of displaying or otherwise using each parameter (eg: altimeter, mach meter, ASI, VSI)

List 3

Precision pressure indicators

Digital pressure indicators

Vacuum and differential pressure chambers

List 4

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

List 5

Sensors (AOA and stall)

Warning – audible, stick shaker

Angle of attack (alpha) limiter

List 6

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

List 7

Principles of operation of eg:

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

List 8

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

List 9

Fluid pressure

Position indication

Engine speed

Cabin temperature

Engine temperature

Fuel contents

Fuel flow

List 10

Gyroscopic principles, directional and rate gyros

Instruments eg: turn and slip indicator, artificial horizon, direction indicator

List 11

Purpose and legal requirements

Typical inputs, recording media, power supplies, installation, locator beacon.

Unit 210 Maintaining aircraft avionic systems

Outcome 2 Understand fixed-wing flying control systems

Assessment Criteria

The learner can:

1. explain servomechanisms
2. explain control, indication and positioning systems
3. explain how compensation is applied to RPC servo systems
4. explain how digital and analogue techniques are applied to control systems
5. explain the operation of a fly-by-wire system
6. explain the operation of a basic autopilot
7. explain the how inputs from external systems contribute to autopilot operation

Range/Scope/Unit content

List 1

Principles and techniques including:

Servomechanism, open loop, closed loop, feedback (positive and negative), follow-up, analogue, transducer, null, damping, dead band, hunting, resolvers, differential, control and torque, E&I transformers, inductance and capacitance transmitters, synchronous transmitters

List 2

Principles and operation of eg:

Control: primary and secondary flight controls, trim

Indication: flap/slat position, trim position, autopilot engaged

Positioning: remote position control (RPC) – open and closed loop

List 3

Eg: error rate, transient, integral

List 4

Nil

List 5

Using block and signal flow diagrams

List 6

In auto-stab manual reversion and full authority modes

Modes of operation: roll, pitch and yaw channels

List 7

Using block and signal flow diagrams

Inputs from: compass, air data, radio, radar, INS

Auto throttle,

Automatic landing systems: principles, modes of operation, approach, glideslope, land, go-around, system monitors, failure conditions.

Unit 210 Maintaining aircraft avionic systems

Outcome 3 Understand aircraft electrical power distribution systems

Assessment Criteria

The learner can:

1. explain the requirements of aircraft power supply systems
2. explain aircraft electrical system components
3. describe aircraft electrical distribution panels
4. describe aircraft busbars
5. explain circuit breakers and fuses
6. explain manual and automatic switches
7. describe the use of terminal blocks in aircraft electrical circuits.

Range/Scope/Unit content

List 1

Eg: AC, DC, emergency, redundancy, load shedding, real and apparent power

List 2

Need for and function of typical systems eg: generators, cable, panels, batteries, invertors, bus power control unit

List 3

Purpose and typical location

List 4

Types, classifications and purposes

List 5

Purpose and operating principles

List 6

Purpose and operating principles of eg:
Micro-switches
Sequence timers
Purpose of caged and guarded switches including purpose of tell-tales

List 7

Application and purpose eg: power and signal distribution.

Unit 210 Maintaining aircraft avionic systems

Outcome 4 Understand aircraft management, lighting and warning systems

Assessment Criteria

The learner can:

1. identify lamp types used on aircraft
2. describe hazards and safety precautions associated with aircraft lamps
3. describe aircraft lighting systems
4. describe safety implications of operating aircraft lighting systems
5. describe aircraft visual and audible warning systems
6. describe on-board maintenance systems
7. explain how on-board maintenance systems are used for structural monitoring.

Range/Scope/Unit content

List 1

Eg: high intensity strobes, identification lights, miniature bulbs, fibre optics, halogen, LED, fluorescent

List 2

Eg: handling, checking ratings; checking power supplies, switches and circuit breakers, disposal

List 3

The purpose and operation of typical aircraft internal and external systems eg:

Cabin, cockpit, cargo and equipment bays

External identification

Landing lights

Ice detection

List 4

Hazards and safety precautions eg: high intensity, particularly at night, high voltage (strobes), lack of light dangerous to others

List 5

Need for and function of eg: advisory, emergency, centralised warning panels, master warning system indicating unseen state of equipment (eg: undercarriage movement, position, locked/unlocked, flaps travelling), proximity, fire

List 6

Typical system, purpose and operation

Including: central maintenance computers, data loading system, electronic library system, printing facilities

List 7

Overview of sensors (strain gauges etc) and monitoring software to monitor damage tolerance.

Unit 210 Maintaining aircraft avionic systems

Outcome 5 Understand aircraft engine electrical systems

Assessment Criteria

The learner can:

1. explain Auxiliary Power Units (APU)
2. describe aircraft gas turbine engine starting systems
3. describe aircraft gas turbine engine ignition systems
4. explain aircraft engine control systems.

Range/Scope/Unit content

List 1

Explain the purpose and describe principles of operation of a typical APU
Requirement for airborne and ground auxiliary power
Outputs (electrical, hydraulic, pneumatic)
Types of motive power eg: ram air, gas turbine engine
Methods of driving generators and obtaining electrical power

List 2

Components, function and principles of operation of a typical system
Requirements for a starting system eg: generate large amounts of torque
Types of starting system eg: air, electrical, hydraulic
Basic terms – starter generator dealt with in outcome 7

List 3

Components, function and principles of operation of a typical system eg:
How and where fuel is burned, need for reliable ignition source, HEIU, igniters, start sequence

List 4

Purpose and principle of operation of a typical system eg:
What the control system is required to do
Sensors, inputs, outputs
What needs to be controlled, how it is controlled
Types of controller including FADEC.

Unit 210 Maintaining aircraft avionic systems

Outcome 6 Understand aircraft electrical power sources

Assessment Criteria

The learner can:

1. explain single generator systems
2. explain multi-generator/starter systems
3. explain non-paralleling ac generator systems
4. explain paralleling ac generator systems
5. explain ac generator drive systems
6. explain static inverters
7. explain transformer rectifier units.

Range/Scope/Unit content

List 1

Purpose and principle of operation of a typical system including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, regulation, switching

List 2

Purpose and principle of operation of a typical system including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, regulation, switching

List 3

Purpose and principle of operation of a typical system including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, regulation, switching

List 4

Purpose and principle of operation of a typical system including: typical applications, reasons for using this system, layout, components, inputs, outputs, protection, regulation, switching

List 5

Purpose and describe the principle of operation including: requirements of a drive system, constant speed drive, source of motive power, location of drive unit, method of coupling and transmission, safety devices

List 6

Purpose and describe the principle of operation including: requirement to convert dc to ac electronically (under what circumstances), how it is done – power source, basic circuit and output waveforms

List 7

Purpose and describe the principle of operation including: requirement to convert primary ac to 28vdc, how it is done – power sources, basic circuit, output waveform (stability, low harmonic content, EMI filtering).

Unit 210 Maintaining aircraft avionic systems

Outcome 7 Understand aircraft communication systems

Assessment Criteria

The learner can:

1. describe the basic principles of electro-magnetic wave propagation
2. describe radio transmitters and receivers
3. explain the basic principles of RF transmission lines
4. explain the principles of operation of radios transmitting in a range of modes
5. describe airborne communication systems
6. describe airborne aerial systems
7. explain satellite communication transmission
8. explain emergency locator beacons
9. Explain the principles of a Time Domain Reflectometer (TDR)

Range/Scope/Unit content

List 1

For all airborne frequency bands

Antenna

List 2

Describe the principles and techniques of basic systems eg: basic components of transmitter and receiver, production of carrier, modulation, tuning

List 3

Eg: materials, cables and other media, connectors, screening

List 4

HF, VHF, UHF, cabin interphone

Additional equipments eg: mobile telephony, Wi-Fi, Ku band satellite broadband, HF data link, ARINC communication and reporting, secure speech and agile frequency

List 5

To block schematic level

AM, FM, CW, SSB,

Benefits and limitations

List 6

Eg: antenna footprint, conformal antenna, backplane, propagation pattern, range

List 7
Basic principles of eg:
Frequency band
Signal type
Power
Steerable-beam antenna
Limitations

List 8
Purpose and operation of eg:
Power supply
Transmission type and frequency
Operation
Testing
Precautions

List 9
Describe the equipment
Need for a TDR
Specific methods of use, instead of a conventional continuity tester
Capabilities and limitations.

Unit 210 Maintaining aircraft avionic systems

Outcome 8 Understand aircraft navigation systems

Assessment Criteria

The learner can:

1. explain basic navigational terms
2. describe radio navigation systems
3. explain the principles of magnetic compasses
4. describe the main components and operating principles of a Magnetic Heading Reference System (MHRS)
5. explain the basics of integration
6. describe motion sensing devices used in navigation
7. explain Inertial Navigation Systems (INS)
8. explain how an IN system's performance is updated using external data
9. explain computing methods used in navigation systems
10. describe airborne surveillance radar systems
11. describe radio and radar height finding systems

Range/Scope/Unit content

List 1

Including: attitude, heading, track, drift angle, latitude, longitude

List 2

Using basic block schematic diagrams

Including: VOR, ILS, MLS, DME, GPS, ADF, emergency locator transmitters

List 3

Eg: magnetic principles, the Earth as a magnet, magnetic variation, errors in magnetic systems, construction of magnetic compasses, reading magnetic compasses, adjustments (compass swing)

List 4

Eg: sensing, computation, indication, adjustment (compass swing), advantages and limitations

List 5

Sufficient only to understand the principles of inertial navigation

List 6

Construction and operating principles of typical devices including:

Single degree of freedom rate gyro

Ring laser gyro

Force re-balance accelerometer

Rate integrating gyro

List 7

Principles and techniques

Purpose, advantages and disadvantages

Basic construction of an inertial platform eg: accelerometers, gyros, mounting frame, suspension bearings (conventional, fluid)

Measurements, calculations (basic to understand process), errors and error correction (eg: basic explanation of Coriolis effect, Schuler tuning)

Typical IN alignment sequence, calibration alignments

System block diagram of a typical IN system

Explain 'strap-down' IN systems

List 8

Eg: updating using GPS or other references, Kalman filtering, integrated systems

List 9

Analogue and digital

Examples of use of each in typical systems

How each type contributes to the system

Decline of analogue methods

List 10

Including: weather radar, SSR

List 11

Additional systems eg: TCAS, airborne intercept radar, Ground Proximity Warning Systems, radio and radar altimeters, other radar sensing and transmitting equipment.

Unit 210 Maintaining aircraft avionic systems

Outcome 9 Be able to maintain aircraft avionic systems

Assessment Criteria

The learner can:

1. carry out maintenance activities on aircraft instrumentation
2. carry out maintenance activities on aircraft communication and navigation equipment
3. operation an aircraft flying control system
4. undertake maintenance activities on an aircraft flying control system
5. test an auto-stabilisation system
6. carry out maintenance activities on an aircraft electrical system.

Range/Scope/Unit content

List 1

Identify aircraft instrumentation
Connect and operate test equipment
Read and interpret instruments
Remove and refit system components

List 2

Identify aircraft communication and navigation system components
Maintenance activities eg:
Use functional test, BITE
Connect and operate test equipment
Read and interpret instruments
Identify symptoms, likely causes
Use appropriate trouble-shooting methods to identify faulty LRU
Remove and refit system components

List 3

Assist in the system operation

List 4

Eg:
Inspection
Replacement of components

List 5

Eg:
Fixed wing auto-stabilisation

List 6

Identify, operate and maintain aircraft electrical system components

Connect and operate electrical test equipment eg: multimeter, insulation tester, TDR

Read and interpret instruments

Remove and refit system components.

Unit 210 Maintaining aircraft avionic systems

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 parts of the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 13 (13.3-5, 13.8-10) and Module 14.

The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B2 category - are listed below with an abridged description of each level:

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

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

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

Unit 215 Aviation mathematics and science for technicians

Level: 3
Credit value: 8
UAN: D/503/1128

Unit aim

This unit aims to give the learner the maths and science knowledge in an aviation context to allow further study of aircraft manufacturing and maintenance practices.

Learning outcomes

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

1. be able to use principles of arithmetic
2. be able to use SI, Imperial and US customary units
3. be able to manipulate algebraic expressions and formulae using standard techniques
4. be able to calculate physical properties of common two and three dimensional shapes
5. be able to use graphs to determine values and solve engineering problems
6. understand the nature of matter
7. understand principles of statics
8. understand principles of types of motion related to aircraft in flight
9. understand principles of dynamics related to aircraft in flight
10. understand principles of fluid motion related to aircraft in flight

Guided learning hours

It is recommended that **70** 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 155, 177 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:

- An online multiple choice test.

Unit 215 Aviation mathematics and science for technicians

Outcome 1 Be able to use principles of arithmetic

Assessment Criteria

The learner can:

1. define arithmetical terms
2. use standard operators on arithmetical expressions
3. calculate the LCM and HCF of arithmetical expressions
4. use basic operators on fractions
5. convert between fraction, decimal and percentage values
6. simplify fractions by cancelling
7. distinguish between ratio and proportion
8. calculate percentage values for common engineering variables
9. calculate by manipulating simple arithmetic ratios
10. distinguish between direct and inverse proportion
11. calculate the constant of proportionality for arithmetical expressions.
12. define types of decimal values
13. distinguish between 'significant figures' and 'decimal places'
14. convert numbers to standard form
15. manipulate arithmetic expressions in standard form
16. estimate values for expressions involving decimal values.

Range/Scope/Unit content

List 1

Including: positive, negative and real numbers

List 2

Add, subtract, multiply, divide

A range of first degree expressions in an aeronautical context

List 3

Expressions with at least four component values

List 4

Basic rules of fractions

Proper and improper fractions

List 5

Standard fractions found in engineering (eg: imperial sizes)

Non-standard 'awkward' fractions

Proper and improper fractions

List 6

Suitable proper and improper fractions

List 7
Nil

List 8
Eg:
Engine thrust
Voltage variation
Fuel tank contents

List 9
Nil

List 10
Nil

List 11
Nil

List 12
Recurring
Terminating
Non-terminating

List 13
Definitions and examples

List 14
Using more complex expressions than in '2.' with all basic operators

List 15
Rules of estimation
Practice with and without calculator
The implications of erroneous estimation in an engineering context.

Unit 215 Aviation mathematics and science for technicians

Outcome 2 Be able to use SI, Imperial and US customary units

Assessment Criteria

The learner can:

1. define the base SI units of measurement
2. define the base Imperial units of measurement
3. convert base and derived units between Imperial, US Customary and SI units
4. calculate derived unit conversion factors using base units
5. explain the terms 'relative error' and 'absolute error'
6. apply error arithmetic to experimental data
7. convert aircraft fuel loads between US Customary, Imperial and SI units
8. convert system pressures between Imperial and SI units
9. extract data from analogue and digital system gauges

Range/Scope/Unit content

List 1

Metre, kilogram, second, ampere, Kelvin, Pascal, Newton Joule

Names and symbols for preferred prefixes:

Giga G), mega (M), kilo (k), nano (n), pico (p)

Include their typical uses

List 2

Foot (ft), pound (lb), minute (min), Fahrenheit (F)

Include their typical uses

List 3

All those commonly used in engineering

With and without a calculator

Derived SI units eg: Hertz, Newton, Pascal, Joule, Watt, Volt, Ohm, °Celsius, Kelvin

Compound derived units eg:

Metres per second

Newton metre

Relevant US Imperial measures eg: US gallons

Imperial: feet, inches, yards, pounds (lb), Imp gallons,

List 4

Using both arithmetical means and standard reference tables/graphs/calculators

For Imperial and SI systems

List 5
Explanation of the definition
Using suitable examples from engineering

List 6
Relevant to engineering
Tolerance

List 7
Pounds, kilograms, litres, imperial gallons, US gallons
Explain the reasons for doing this accurately

List 8
Eg:
Pascal
Bar
Atmosphere
Psi
Nm^{-2}
Explain the reasons for doing this accurately

Note: Simulation in the form of representative drawings or photographs of relevant gauges can be used when real equipment is not available

List 9
Using common scales eg: pounds, kilograms, litres, US gallons
Aircraft and refueler fuel gauges
Aircraft system pressure gauges
Ground support system pressure gauges

List 10
Eg: oxygen, nitrogen, air, fuel

List 11
Eg: oxygen, nitrogen, air, fuel

Unit 215 Aviation mathematics and science for technicians

Outcome 3 Be able to manipulate algebraic expressions and formulae using standard techniques

Assessment Criteria

The learner can:

1. factorise algebraic expressions
2. define 'algebraic expression', 'equation' and 'identity'
3. simplify expressions containing brackets, powers and roots
4. solve simultaneous equations
5. solve second degree equations
6. evaluate aeronautical and scientific formulae by substituting data
7. use formulae to obtain engineering and scientific data

Range/Scope/Unit content

List 1

By grouping and extracting common factors

List 2

Basic definitions with examples

List 3

Using BODMAS
Including nested brackets
Indices and powers
Negative and fractional indices

List 4

Simple equations using basic methods

List 5

With one unknown

List 6

Eg:
Gas laws
Aircraft weighing
Aircraft loading (C of G etc)

List 7

Eg:
Specific gravity
Pressure
Temperature and heat.

Unit 215 Aviation mathematics and science for technicians

Outcome 4 Be able to calculate physical properties of common two and three dimensional shapes

Assessment Criteria

The learner can:

1. define the components of a circle
2. solve problems related to dimensions of a circle
3. create geometrical constructions
4. use coordinate systems
5. use formulae to calculate dimensions of plane figures
6. use formulae to calculate surface area and volume of common solids.

Range/Scope/Unit content

List 1

Radius
Diameter
Circumference
Arc
Chord

List 2

Radius
Diameter
Circumference

List 3

Simple constructions on paper eg:
Triangle
Square
Rectangle
Parallelogram
Circle

List 4

Rectangular
Polar

List 5
Using:
sine, cosine and tangent relationships
Triangle
Square
Rectangle
Parallelogram

List 6
Cube
Cylinder
Cone
Sphere

Unit 215 Aviation mathematics and science for technicians

Outcome 5 Be able to use graphs to determine values and solve engineering problems

Assessment Criteria

The learner can:

1. select scales and origins for graph axes
2. extract values from graphs
3. extrapolate linear graphs to determine x and y intercepts
4. determine *y, x, m and c* from linear equations and graphs
5. solve graphically pairs of simultaneous equations
6. recognise graphical representations of sine and cosine waveforms
7. determine data values from graphs and tables
8. apply graphical techniques to the solution of engineering problems.

Range/Scope/Unit content

List 1

By examining experimental data using various origins

List 2

Including interpolate between known points

List 3

Extrapolate Graph Trends

List 4

Graphically and by calculation

List 5

First order equations

List 6

Recognise peak values and phase difference

List 7

Pressure
Density
Relative density
Temperature

List 8

Eg:
ICAO tables
Take-off performance graphs
Fuel data.

Unit 215 Aviation mathematics and science for technicians

Outcome 6 Understand the nature of matter

Assessment Criteria

The learner can:

1. explain the kinetic theory of matter
2. identify common engineering chemical elements by name and symbol
3. explain the three basic states of matter and the changes of state of common substances
4. explain the three main bonds at molecular level
5. describe the nature of molecules found in metals and non-metals
6. explain the difference between heat and temperature
7. explain the relationship between the common temperature scales
8. convert temperature values between the common temperature scales
9. use the ISA tables to derive specific values.

Range/Scope/Unit content

List 1

Explanation including:

Random motion of particles

Brownian motion

Gas properties of pressure, temperature and volume

Conduction, Convection, Radiation, Adiabetic compression

List 2

Eg carbon, iron, aluminium, copper

List 3

Solid, liquid, gas

Include all state changes: solid > liquid > gas >liquid > gas

Basic explanation of latent heat

Common features of state changes such as the expansion of water when frozen.

List 4

Metallic

Ionic

Covalent

Relative strengths of each bond

Reasons for forming each type

List 5
Materials used in aircraft eg:
Steel
Aluminium alloys
Plastics
Conductors
Insulators

List 6
Engineering explanation using aircraft related examples

List 7
Kelvin
Degrees Fahrenheit
Degrees Celsius
Thermometers

List 8
Kelvin
Degrees Fahrenheit
Degrees Celsius

List 9
Eg:
Altitude
Temperature
Density.

Unit 215 Aviation mathematics and science for technicians

Outcome 7 Understand principles of statics

Assessment Criteria

The learner can:

1. identify forces represented graphically as vectors
2. explain the concept of equilibrium
3. define the meaning of 'the moment of a force about a point'
4. define centre of gravity
5. solve problems involving straight levers, bell cranks and aircraft loading
6. solve problems graphically using the 'triangle of forces' theorem
7. solve problems graphically using the 'parallelogram of forces' theorem
8. define pressure and its units
9. explain the difference between gauge pressure and absolute pressure
10. solve problems involving atmospheric, gauge and absolute pressures
11. calculate pressures in liquids using basic physical measurement.

Range/Scope/Unit content

List 1

Define 'vector'

Draw vector lines to represent forces in a system

List 2

With respect to mechanical systems

List 3

Basic principle of moments

List 4

Explain the meaning

Examples of position in common objects including aircraft

List 5

Relate problems to aircraft eg:

Bell crank on control cables

Aircraft balance about main undercarriage on the ground

Aircraft loading to adjust C of G

List 6

Including some aircraft-related problems

List 7

Including some aircraft-related problems

List 8
The atmosphere
Free liquids and gases
Constrained liquids and gases
Stress and strain of materials
Gas laws (Boyle's Charles)

List 9
Aircraft-related examples

List 10
Aircraft related

List 11
Measuring height
Applying ρ p = þ gh

Unit 215 Aviation mathematics and science for technicians

Outcome 8 Understand principles of linear, angular and oscillating motion related to aircraft in flight

Assessment Criteria

The learner can:

1. define speed, velocity and acceleration
2. state Newton's Laws of Motion
3. explain the relationships F = ma and W = mg
4. define the equations of linear motion for constant acceleration
5. solve problems related to an aircraft in flight
6. define basic terms for angular motion
7. define terms for oscillating motion
8. explain simple harmonic motion in terms of mass-spring and simple pendulum systems
9. calculate the natural frequency of small oscillations in a pendulum.

Range/Scope/Unit content

List 1

Including acceleration due to gravity and its approximate value

List 2

In standard form

Include aircraft-related examples

List 3

Including aircraft-related examples

List 4

$s = ut + \frac{1}{2}at^2$

$v = u + at$

$v^2 = u^2 + 2as$

List 5

Using:

Newton's Laws of Motion

Linear motion equations

List 6

Centripetal acceleration

Centrifugal force

Angular velocity

Calculations

List 7
For elastic systems:
Free vibration
Simple harmonic motion
Forced vibration
Resonance
Time period
Cycle
Frequency
Amplitude

List 8
Applying definitions in (7.)

List 9
Using the simplified version of the pendulum formula for small oscillations.

Unit 215 Aviation mathematics and science for technicians

Outcome 9 Understand principles of dynamics related to aircraft in flight

Assessment Criteria

The learner can:

1. define terms relating to simple machines
2. solve problems involving simple machines
3. explain terms related to gyroscopic motion
4. define work and power
5. define common forms of energy
6. explain the concept of the conservation of energy
7. solve simple problems involving potential and kinetic energy
8. explain terms related to friction
9. solve simple problems involving friction affecting objects on horizontal surfaces.

Range/Scope/Unit content

List 1

Velocity ratio
Mechanical advantage
Efficiency

List 2

Related to aircraft where possible:
Relationship between pressure, force and area
Pulley systems
Worm and wheel
Levers
Gears
Screw jack
Efficiency

List 3

Momentum
Inertia
Rigidity
Precession
Gimbal Lock, Degrees of freedom

List 4

Calculations

List 5
Potential
Kinetic
Heat
Electrical
Chemical

List 6
Eg: ‘energy can neither be created nor destroyed, but only converted from one form to another’

List 7
Related to aircraft where possible

List 8
Static friction
Dynamic friction
Coefficient of friction
Reaction
Normal force

List 9
Applying definitions in 8

Unit 215 Aviation mathematics and science for technicians

Outcome 10 Understand principles of fluid motion related to aircraft in flight

Assessment Criteria

The learner can:

1. explain density and relative density (specific gravity)
2. solve simple problems involving changing altitude
3. explain viscosity
4. describe the effects of streamlining on the properties of air over an aerofoil surface
5. explain Bernoulli's Principle for a non-viscous fluid
6. explain the relationship between Bernoulli's principle, a venturi and lift on an aerofoil

Range/Scope/Unit content

List 1

Including practical examples eg: fuel

List 2

Changes with altitude of air properties:

Density

Pressure

Temperature

List 3

In terms of:

Resistance to fluid flow

Shear stresses close to the system boundary

List 4

Velocity of the air

Resistance of the air

List 5

Eg: potential energy, kinetic energy and pressure energy remain constant in the streamline

List 6

Simplified explanation.

Unit 215 Aviation mathematics and science for technicians

Notes for guidance

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

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

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

Level 1 – "A familiarisation with the principal elements of the subject"

Level 2 – "A general knowledge of the theoretical and practical aspects of the subject"

Level 3 – "A detailed knowledge of the theoretical and practical aspects of the subject"

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

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

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.

City & Guilds

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www.cityandguilds.com

Useful contacts

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