QUALIFICATION HANDBOOK

Level 3 Diploma in Aircraft Maintenance (Civil Aircraft Mechanical) (2675-05)

EASA Part 66 Aircraft Maintenance Licence (Category A.1) theory elements

February 2019 Version 2

City & Guilds

Qualification at a glance

Subject area	Aviation Engineering
City & Guilds number	2675-05
Age group approved	16-18, 19+
Entry requirements	This qualification is included in the Apprenticeship standard Aircraft Maintenance Fitter/Technician (Fixed and Rotary Wing). Individual employers will set the criteria, but most candidates will have four GCSEs C grade (or equivalent) or above on entry (including English, Maths & Science).
Assessment	Centre Devised, Multiple Choice test
Fast track	Full Qualification Approval only
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 (Civil Aircraft Mechanics)	655	800	2675-05	600/1929/3

Version and date	Change detail	Section
V1.1 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 Aerospace and Aviation sector as an aircraft maintenance engineer
What does the qualification cover?	Allows candidates to learn, develop and practise the skills required for employment and/or career progression in the Aerospace and Aviation sector. It enables candidates to work towards EASA Part 66 Aircraft Maintenance Licence (Category A.1) theory elements.
Is the qualification part of a framework or initiative?	The qualification is included in the Apprenticeship standard Aircraft Maintenance Fitter/Technician (Fixed and Rotary Wing).
What opportunities for progression are there?	Further opportunities for candidates include: • Airworthiness Planning, Quality and Safety Technician.

Structure

Learners require a total of **80 credits** to achieve the Level 3 Diploma in Aircraft Maintenance (Civil Aircraft Mechanics). Learners must obtain 53 credits from the Mandatory Group, plus a minimum of 12 credits from the group Optional Units 1 and a further minimum of 15 credits from the group Optional Units 2.

Mandatory Group

Unit accreditation number	City & Guilds unit no.	Unit title	Credit value
T/503/0860	017	Civil legislation in aviation	5
M/503/1263	035	Human factors in aviation	5
A/503/0956	201	Fundamentals of electronics and avionics	10
D/503/0965	203	Aerodynamics and control in a fixed-wing aircraft	5
R/503/0977	204	Structural materials and components in aircraft	9
R/503/0980	205	Maintaining aircraft structures	11
D/503/1128	215	Aviation mathematics and science for technicians	8

Optional Units 1

Unit accreditation number	City & Guilds unit no.	Unit title	Credit value
T/503/0986	206	Maintaining aircraft mechanical systems	12
M/503/1134	217	Maintaining rotary wing mechanical systems and rotary wing flight controls	12

Optional Units 2

Unit accreditation number	City & Guilds unit no.	Unit title	Credit value
A/503/1105	207	Maintaining gas turbine engines and propellers	15
H/503/1159	216	Maintaining gas turbine engines and rotors	15

Elective Unit

Unit accreditation number	City & Guilds unit no.	Unit title	Credit value
T/507/5894	220	Fundamentals of aircraft wood and fabric maintenance	2

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 (Civil Aircraft Mechanics)	655	800

2 Centre requirements

Approval

Existing City & Guilds centres will need to gain qualification approval, regardless of any approval for existing 2675 (Aircraft Maintenance) qualifications.

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the *City & Guilds Centre Manual* for further information.

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

EASA Part 66 Aircraft Maintenance Licence (Category A.1)

City & Guilds has received accreditation from the Civil Aviation Authority (CAA) for the qualification which has been mapped to EASA Part 66 Aircraft Maintenance Licence (Category A.1) theory elements. Please note candidates will still need to demonstrate they meet the experience requirements specified in Part 66.A.30 Basic Experience Requirements. The following wording will be included on the City & Guilds certificate:

"This certificate supports the issuance of an EASA Part 66 Aircraft Maintenance Licence (Category A.1) theory elements. Applicants will still need to demonstrate they meet the experience requirements specified in Part 66.A.30 Basic Experience Requirements."

City & Guilds will periodically provide the CAA with reports detailing Centres approved to offer the qualification, registered candidates and candidates who have successfully achieved a 'merit' grade in all their chosen units within the qualification.

Centres should also note as part of our agreement with the CAA we have an obligation to allow the CAA access to our Centres. City & Guilds also has a requirement to inform the CAA of any instance of malpractice and it is important that Centres gain consent from candidates to allow disclosures to be made to the CAA.

Internal Quality Assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications.

Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance.

Internal Quality Assurance requirements

Staff must:

- have experience in quality management/internal verification

or

- hold or be working towards an appropriate internal quality assurance qualification

and

- be familiar with the occupation and technical content covered within the qualification
- be familiar with the Engineering Technician (UK spec) requirements where delivering/assessing Level 3, they will be required to provide a signed declaration confirming they have read and understood the Engineering Technician UK spec and the evidence requirements to meet the engineering technician (UK spec) criteria.

Teacher/Trainer/Lecturer/Assessor requirements

Staff must:

- have relevant experience in teaching/training/assessing

or

- hold or be working towards an appropriate teaching/training/assessing qualification

and

- be technically knowledgeable in the area(s) for which they are delivering training/assessing, with appropriate qualifications
- be familiar with the Engineering Technician (UK spec) requirements where delivering/assessing Level 3, they will be required to provide a signed declaration confirming they have read and understood the Engineering Technician UK spec and the evidence requirements to meet the engineering technician (UK spec) criteria.

Full details and guidance on the internal and external quality assurance requirements and procedures are provided in the *Centre Manual – Supporting Customer Excellence*, which can be found on the centre support pages of **www.cityandguilds.com**. This document also explains the tasks, activities and responsibilities of quality assurance staff.

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.

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

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.

Age restrictions

City & Guilds cannot accept any registrations for candidates under 16 as these qualifications are not approved for under 16s.

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.

It is important to note Candidates must achieve a merit grade in every unit to be considered for an EASA Part 66 Aircraft Maintenance Licence (Category A.1).

Mandatory Units

City & Guilds unit number	Unit title	Assessment method
2675-017	Civil legislation in aviation	CAA or Short-Answer
2675-035	Human factors in aviation	e-assessments
2675-201	Fundamentals of electronics and avionics	e-assessments
2675-203	Aerodynamics and control in a fixed-wing aircraft	e-assessments
2675-204	Structural materials and components in aircraft	Centre Devised Assignment
2675-205	Maintaining aircraft structures	Centre Devised Assignment
2675-215	Aviation mathematics and science for technicians	e-assessments

Optional Units 1

City & Guilds unit number	Unit title	Assessment method
2675-206	Maintaining aircraft mechanical systems	Centre Devised Assignment
2675-217	Maintaining rotary wing mechanical systems and rotary wing flight controls	Centre Devised Assignment

Optional Units 2

City & Guilds unit number	Unit title	Assessment method
2675-207	Maintaining gas turbine engines and propellers	Centre Devised Assignment
2675-216	Maintaining gas turbine engines and rotors	Centre Devised Assignment

Elective Unit

City & Guilds unit number	Unit title	Assessment method
2675-220	Fundamentals of aircraft wood and fabric maintenance	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 **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 EQA for inspection.

Grading

Candidates will achieve either a pass, merit or distinction for each unit.

Candidates that achieve a merit or above in **each** unit, will receive the following wording on the City & Guilds certificate:

"This certificate supports the issuance of an EASA Part 66 Aircraft Maintenance Licence (Category A.1) theory elements. Applicants will still need to demonstrate they meet the experience requirements specified in Part 66.A.30 Basic Experience Requirements."

City & Guilds will periodically provide the CAA with reports candidates who have successfully achieved a 'merit' grade in all their chosen units within the qualification.

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 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 2: 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 3: 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 4: 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
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. They can also be obtained from The Register of Regulated Qualifications: **http://register.ofqual.gov.uk/Unit**

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
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance

Unit 017 Civil legislation in aviation

Level: **3**

Credit value: **5**

UAN: **T/503/0860**

Unit aim

This unit aims to give the learner a working knowledge of aviation legislation to enable maintenance work to be done within the requirements of the Law. It covers the complete syllabus for EASA Part-66 Module 10 for Category B1 and B2 Licences (dated 16/11/2011.) Please note EC 1702/2003 was replaced by EU.748/2012.

Learning outcomes

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

1. understand the roles of European and International aviation safety organisations
2. understand the requirements for aircraft maintenance personnel and organisations
3. understand the European requirements for aircraft certification
4. understand the contents of Part-M and other National and International requirements.

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 302, 311 etc.

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

Assessment and grading

This unit will be assessed by:

- an assignment covering underpinning knowledge.

Unit 017 Civil legislation in aviation

Outcome 1 Understand the roles of European and International aviation safety organisations

Assessment Criteria

The learner can:

1. describe the role of the International Civil Aviation Organisation (ICAO)
2. describe the role of the European Aviation Safety Agency (EASA)
3. describe the role of the European Commission (EC)
4. describe the role of the EU Member States and National Aviation Authorities
5. explain the relationships between parts of the European Aviation Safety Regulations.

Range/Scope/Unit content

List 1

Overview of ICAO eg:

Purpose

Areas of operation

Powers

List 2

Overview of EASA eg:

Purpose

Areas of operation

Powers

List 3

Overview, with respect to EASA and European aviation

List 4

Overview of obligations and responsibilities for aviation safety

List 5

Overview of Regulation (EC) No 216/2008 and its implementing rules Regulations (EC) No EU.748/2012 and (EC) No 2042/2003

Overview of the relationship between the following: Part-21, Part-M, Part-145, Part-66, Part-147 and EU-OPS.

Unit 017 Civil legislation in aviation

Outcome 2 Understand the requirements for aircraft maintenance personnel and organisations

Assessment Criteria

The learner can:

1. explain the training and certification requirements for Maintenance Certifying Staff
2. explain the requirements for Approved Maintenance organisations
3. explain the requirements of EU-OPS for Commercial Air Transportation.

Range/Scope/Unit content

List 1

Detailed understanding of Part-66 including:
Details of the requirements for the issue of licences to maintenance personnel
The approved basic training course
Examinations
Practical experience
Log books
Privileges of a Licensed Aircraft Maintenance Engineer in each category

List 2

Detailed understanding of: Part 145 and Part-M Subpart F including:
Approval
Maintenance Organisation Exposition (145)/Manual (Subpart F)
Facilities
Personnel requirements
Certifying staff
Components, equipment and tools
Maintenance data, work orders and standards
Release-to-service certification of aircraft and components
Maintenance records
Privileges of the organisation
Organisational changes
Review of the organisation
Continuing approval and 'findings'

List 3

Overview of:
Commercial Air Transport/Commercial Operations
Air Operators Certificates
Operators Responsibilities – particularly continuing airworthiness and maintenance
Documents to be carried on board
Aircraft placarding (markings).Safety Management Systems (SMS) this may be placed under Operator's responsibilities but the requirement is mandatory and places obligations on the whole supply chain, including maintenance organisations.

Unit 017 Civil legislation in aviation

Outcome 3 Understand the European requirements for aircraft certification

Assessment Criteria

The learner can:

1. explain the general aircraft certification rules
2. explain type certification
3. explain Supplemental Type Certification
4. explain Part-21 Design/Production Organisation Approvals
5. explain the Certificate of Airworthiness
6. explain the Certificate of Registration
7. explain the Noise Certificate
8. explain the Weight Schedule
9. explain the Radio Station Licence and Approval.

Range/Scope/Unit content

List 1

For aircraft, parts and appliances:
General understanding of Part-21 and EASA certification specifications CS-23, 25, 27, 29

For each of **Lists 2-9**; including:

- Reason for the certificate
- Information shown on the certificate
- Criteria for retention of the certificate
- Criteria for withdrawal of the certificate
- Authority to issue the certificate
- Period of validity.

Unit 017 Civil legislation in aviation

Outcome 4 Understand the contents of Part-M and other National and International requirements

Assessment Criteria

The learner can:

1. explain the purpose of the sub-parts and annexes of Part-M
2. explain further National and International documentation and procedures
3. explain the requirements for Continuing Airworthiness
4. explain the requirements for test flights
5. explain the requirements for ETOPS maintenance and dispatch
6. explain the requirements for All Weather and Category 2/3 operations.

Range/Scope/Unit content

List 1

A detailed understanding of:

Subparts A-I

Appendices I - VIII

List 2

A detailed understanding of Part-21 provisions related to continuing airworthiness

Overview of:

Maintenance Programmes, Maintenance checks and inspections

Master Minimum Equipment Lists, Minimum Equipment List, Dispatch Deviation Lists

Airworthiness Directives

Service Bulletins, manufacturers service information

Modifications and repairs

Maintenance documentation: maintenance manuals structural repair manual, illustrated parts catalogue

Master Minimum Equipment Lists, Minimum Equipment List, Dispatch Deviation Lists

List 3

Meaning of continuing airworthiness; overview of main requirements

List 4

Overview: Minimum equipment requirements — Test flights

List 5

Overview:

Reasons for and principles of ETOPS, main requirements, effect on maintenance activities; dispatch requirements

List 6

Overview including: AWOPS, ILS approaches low-visibility take-off and landing, minimum equipment for aircraft engaged in those categories of operation.

Unit 017 Civil legislation in aviation

Notes for guidance

This unit contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 10 – Aviation Legislation for the Category B1 and B2 Licences. This reflects the amendments to the syllabus dated 16/11/ 2011, fully effective on 1 June 2013. Please note that EC1702/2003 was replaced with EU.748/2012 and that EU.1149/2011 became effective from August 2012 and made changes to all Annexes of EC.2042/2003.

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

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

Outcome 1: EASA Level 1
Outcome 2: EASA Level 2 (except 3 – EASA Level 1)
Outcome 3: EASA Level 2 (except 1 – EASA Level 1)
Outcome 4: EASA Level 1 (except 1&2 – 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 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 B1 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.

Key Skills

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

Communication

Improving Own Learning and Performance

Problem Solving

Working with Others

Assessment and grading

This unit will be assessed by:

An online multiple-choice test.

Unit 035 Human factors in aviation

Outcome 1 Understand why human factors are important in aviation

Assessment Criteria

The learner can:

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

Range/Scope/Unit content

List 1

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

List 2

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

List 3

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

Unit 035 Human factors in aviation

Outcome 2 Understand features and limitations of human performance

Assessment Criteria

The learner can:

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

Range/Scope/Unit content

List 1

To include:
Main parts of the eye
How each part of the eye reacts to light
Rods and cones
Seeing in high and low light
Peripheral vision
Interpretation by the brain

List 2:

To include:
Main parts of the ear
Vulnerable parts of the ear
Effect of noise – percussive, prolonged high intensity, varying pitch
Noise Induced Hearing Loss (NIHL)
Legal requirements for hearing protection
Correct protection for frequency range

List 3

Simple explanation eg:
Time from exposure to information
Form that information is in (audio, visual, words, pictures etc.)
Fatigue
Age
Complexity of information
Artificial stimulants/depressants
Types (iconic, echoic, episodic, symantic)

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

List 5
Individually and 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

The five steps –

1. Identify hazards
2. Decide who might be harmed and how
3. Evaluate risks and decide on precautions
4. Record findings and implement them
5. Review and update

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 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.

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

Lis5

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 203 Aircraft aerodynamics and control in fixed-wing aircraft

Level: 3
Credit value: 5
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

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
Critical angel of attack
Stalling angle

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
Types of drag
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 204 Structural materials and components in aircraft

Level: 3
Credit value: 9
UAN: A/503/0956

Unit aim

The aim of the Unit is to provide learners with a detailed understanding of Aircraft Structural Materials and Components. The Unit covers the use of materials, maintenance and manufacturing practices.

Learning outcomes

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

1. know the properties of aircraft ferrous materials
2. know the properties of aircraft non-ferrous materials
3. understand corrosion in aircraft materials
4. be able to repair corroded airframe components
5. understand the properties of advanced, composite and other non-metallic materials
6. understand general-purpose aircraft components
7. be able to use aircraft fasteners and locking devices
8. know aircraft control cables and transmission systems

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 various mechanical maintenance NOS Units.

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 a short-answer examination covering knowledge and understanding

Unit 204 Structural materials and components in aircraft

Outcome 1 Know the properties of aircraft ferrous materials

Assessment Criteria

The learner can:

1. describe how ferrous materials are identified
2. describe changes in properties of plain carbon steel during heat treatment processes
3. describe changes in properties of plain carbon steel during mechanical working processes
4. describe methods of testing ferrous materials.

Range/Scope/Unit content

List 1

Properties eg:
Grain structure
Alloying elements:
All of: Carbon, Chromium, Nickel, Vanadium, Molybdenum, Manganese, Silicon
Density
Strength
Stress
Strain
Elasticity
Ductility
Malleability
Toughness
Hardness
Brittleness
Creep
Fatigue
Work hardening
Corrosion resistance
Hot and cold performance
Marking of stock bars and sheets

List 2

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

List 3

Hot and cold working

List 4

Eg:

Hardness testing

Tensile testing

Impact testing

Fatigue testing

Creep testing

Unit 204 Structural materials and components in aircraft

Outcome 2 Know the properties of aircraft non-ferrous materials

Assessment Criteria

The learner can:

1. describe how non-ferrous materials are identified
2. describe the heat treatment
3. describe uses of non-ferrous materials
4. describe methods of testing non-ferrous materials.

Range/Scope/Unit content

List 1

Eg:
Grain structure
Common alloying elements - all of: copper, magnesium silicon, zinc
Density and strength
Stress and strain
Elasticity, ductility and malleability
Toughness, hardness and brittleness
Creep
Fatigue
Work hardening
Corrosion resistance
Hot and cold performance
Marking of stock bars and sheets

List 2

Annealing
Solution treatment
Precipitation hardening

List 3

Eg:
Structure
Skin

List 4

Hardness testing
Tensile testing
Impact testing
Fatigue testing
Creep testing

Unit 204 Structural materials and components in aircraft

Outcome 3 Understand corrosion in aircraft materials

Assessment Criteria

The learner can:

1. describe the chemical fundamentals of corrosion
2. describe how corrosion is formed
3. describe the types of corrosion and their identification
4. explain why materials are susceptible to corrosion
5. explain methods to remove and treat corrosion.

Range/Scope/Unit content

List 1

Eg:
Direct chemical action, Galvanic action process

List 2

Environment
Wear
Stress
Microbiological action

List 3

Eg:
Surface
Pitting
Stress
Fatigue
Intergranular
Fretting
Crevice
Exfoliation
Filiform

List 4

Eg:
Steels
Aluminium alloys
Magnesium alloys
Copper
Silver

List 5

Chemical removal
Mechanical removal
Restoration of protective finish
Temporary protective finishes.

Unit 204 Structural materials and components in aircraft

Outcome 4 Be able to repair corroded airframe components

Assessment Criteria

The learner can:

1. identify defects in ferrous materials
2. identify defects in non-ferrous materials
3. classify corrosion in aircraft structures
4. perform removal and repair of corrosion damage.

Range/Scope/Unit content

Lists 1 and 2

Detectable with the naked eye or magnifying glass
Including pipes
Eg cracks, inclusions and distortions following:
Welding
Casting
Working

List 3

Inspect
Identify
Classify in standard categories

List 4

Plan using standard procedures and repair schemes
Repair in non-ferrous material eg:
Remove and blend minor pitting
Patch repair
Insert repair
Protection of repair
Inspection of repair

Unit 204 Structural materials and components in aircraft

Outcome 5 Understand the properties of advanced, composite and other non-metallic materials

Assessment Criteria

The learner can:

1. describe 'advanced' aircraft materials
2. describe the heat treatment of advanced aircraft materials
3. describe characteristics of aircraft composite materials
4. explain the detection of typical defects/deterioration in composite material
5. explain repair techniques for composite materials
6. describe characteristics of sealants and bonding agents
7. describe the characteristics, of non-metallic materials.
8. explain the preservation of non-metallic materials

Range/Scope/Unit content

List 1

Including uses of eg:
Titanium alloys
Aluminium/lithium alloys

List 2

Eg:
Annealing
Hardening

List 3

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

List 4

Eg:
Cracking
Warping
Splitting
De-bonding
Delamination
Barely Visible Impact Damage (BVID)

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

List 6
Properties and identification of eg:
Polyurethane
Silicones
Thread locking compound
Resins
Glues

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

List 8
Preservation and maintenance:
Protective treatments
Inspection

Unit 204 Structural materials and components in aircraft

Outcome 6 Understand general-purpose aircraft components

Assessment Criteria

The learner can:

1. explain the nomenclature of screw threads
2. explain thread systems
3. explain the specification system for aircraft bolts
4. describe nuts, screws, studs and locking devices used on aircraft
5. describe rivet systems
6. describe aircraft pipes and connectors
7. describe unions for hydraulic, fuel, pneumatic and oxygen systems
8. describe aircraft springs
9. describe how springs are inspected and tested
10. explain the purpose of bearings
11. describe types of aircraft bearing
12. describe typical bearing loads
13. describe how bearings are typically inspected and tested
14. describe types of seal used in aircraft applications

Range/Scope/Unit content

List 1

Crest
Form
Root
Thread angle
Pitch
Lead
Major and minor diameters
Depth
Threads per inch
Single and multi-start threads
Right and left hand threads

List 2

ACME
Square
Buttress
Vee threads
BSF
BSW
BA
UNF
UNC
Metric, coarse and fine

List 3
Hexagon head
Cap bolts
Slotted head
High shear bolts
Twelve point head

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

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

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

List 7
Eg:
Flared couplings
Flareless couplings
British metric swaged pipe couplings
American Flareless couplings
Arsaero pipe couplings
Swaged end couplings
Cryogenic pipe couplings
Gamah couplings
Sliding couplings
Quick release connectors

V-flange couplings
Typical pipeline clamping

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

List 9
Testing springs eg:
Measurement
Load test

List 10
Eg:
Reduce friction and wear
Component alignment

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

List 12
Eg:
Axial
Radial
Bending (perpendicular to axis)

List 13
Eg:
Types of damage and wear and their causes
Testing methods
Testing criteria

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

Unit 204 Structural materials and components in aircraft

Outcome 7 Be able to use aircraft fasteners and locking devices

Assessment Criteria

The learner can:

1. use aircraft fixing devices
2. use aircraft locking devices
3. use aircraft rivet systems.

Range/Scope/Unit content

List 1

A range of devices eg:
Nuts, bolts, screws, studs

List 2

A range of devices including:
Lock washers
Locking wire
Split pins

List 3

Solid and blind rivets
Countersunk and snap head rivets
Using appropriate riveting tools
Inspect for defects in riveted joints

Unit 204 Structural materials and components in aircraft

Outcome 8 Know aircraft control cables and transmission systems

Assessment Criteria

The learner can:

1. describe aircraft control cable and mechanisms
2. describe aircraft pulleys and cable system components
3. describe Bowden cables
4. describe flexible control systems
5. describe gear systems
6. describe transmission systems that use belts and pulleys, chains and sprockets.

Range/Scope/Unit content

List 1

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

List 2

Pulleys
Cable tensioning
Tensiometer

List 3

Cable material
Conduit
Typical end fittings
Adjustment
Pull system only

List 4

Teleflex
Conduit
Core cable
Adjustment
Push/Pull systems

List 5

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

List 6

Drive belts and pulleys
Screw jacks
Sprockets
Chains
Typical applications.

Unit 204 Structural materials and components 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 covers skills and knowledge that are required in both manufacturing and maintenance processes. It contains the complete syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 6 – Aircraft Structural Materials and Components , ***with the exception of*** *6.3.2-3 (Wood and Fabric Structures)* ***and*** 6.11 (Electrical cables and Connectors) which is covered in **Unit 201 outcome 4**. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

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

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

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

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

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

Unit 205 Maintaining aircraft structures

Level: 3
Credit value: 11
UAN: R/503/0980

Unit aim

The aim of this unit is to provide learners with a detailed understanding of aircraft structures and maintenance practices. It provides knowledge and understanding for a number of NVQ Diploma units and for parts of EASA part66 Module 7A.

Learning outcomes

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

1. understand safety precautions required when working on aircraft and in workshops
2. understand tools and working practices used on aircraft and in workshops
3. understand engineering drawings, diagrams and standards used on aircraft
4. understand the system of fits and clearances used on aircraft
5. understand airframe structures
6. understand techniques for the assembly and repair of airframe structures and components
7. be able to use techniques for the assembly of airframe structures and components
8. understand maintenance procedures for the safe and effective operation of aircraft.

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 13, 14.

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 205 Maintaining aircraft structures

Outcome 1 Understand safety precautions required when working on aircraft and in workshops

Assessment Criteria

The learner can:

1. explain legislative requirements for aircraft-related workplaces
2. explain safe working practices used in aircraft-related workplaces
3. explain actions to be taken in workplace emergencies.

Range/Scope/Unit content

List 1

Health and Safety legislation
Environmental protection legislation
Hazardous substance legislation

List 2

Aircraft movement – taxiing/towing
Aircraft jacking, chocking and securing
Aircraft storage
Environmental effects on aircraft handling and operation
Aircraft engine intakes, exhausts and propellers
Radio wave radiation
Hazards eg noise, working at height, manual handling, slips, trips falls
Electricity
High pressure gases including oxygen
Oils
Fuels
Chemicals

List 3

With reference to:
First aid fire appliances
First aid
Mains power supplies.

Unit 205 Maintaining aircraft structures

Outcome 2 Understand tools and working practices used on aircraft and in workshops

Assessment Criteria

The learner can:

1. describe hand and power tools
2. describe precision tools and measuring equipment
3. explain lubrication methods
4. explain the care and control of equipment and spares
5. explain quality standards in aircraft manufacture.

Range/Scope/Unit content

List 1

Hand and power operated including:
Spanners
Drills
Sockets
Wrenches
Screwdrivers
Air tools
Electrical equipment

List 2

The calibration, operation, and typical use:
Reasons for and importance of calibration
Record keeping
Labelling of tools
Calibration equipment
Calibration intervals
Calibration standards
Calibration process
Equipment eg:
Torque loading and torque calibration tools
Forming tools such as crimpers
Micrometers
Verniers
Dial test indicators
Plug gauges
Feeler gauges
Pressure gauges

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

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

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

Unit 205 Maintaining aircraft structures

Outcome 3 Understand engineering drawings, diagrams and standards used on aircraft

Assessment Criteria

The learner can:

1. explain engineering drawings
2. describe title block and associated information
3. explain methods of presenting technical information.

Range/Scope/Unit content

List 1

Type of projection (First angle, third angle)
Orthographic
Isometric
Eg ISO, AN, MS, NAS, MIL, ATA 100

List 2

Units and dimensions
Scale
Title
Author
Issue number

List 3

Eg:
Microfilm
Microfiche
Computerised presentation.

Unit 205 Maintaining aircraft structures

Outcome 4 Understand the system of fits and clearances used on aircraft

Assessment Criteria

The learner can:

1. explain drill sizes for bolts
2. explain the common system of fits and clearances
3. explain limits of bow, twist and wear
4. explain standard methods for checking shaft assemblies.

Range/Scope/Unit content

List 1

Pilot drill
Tapping drill
Clearance drill

List 2

For aircraft and engines:
ISO, BS
Clearance, Interference, Transition fits

List 3

Ovality
Bowing
Distortion

List 4

Shafts, bearings, and other associated parts for eg:
Roughness
Trueness
Wear
Structural integrity
Corrosion.

Unit 205 Maintaining aircraft structures

Outcome 5 Understand airframe structures

Assessment Criteria

The learner can:

1. describe general airworthiness requirements for airframe structures
2. describe zonal and station identification systems
3. explain stress systems found in aircraft structures
4. explain the need for drains and ventilation in structures
5. explain how aircraft are protected from static build-up and lightning strikes
6. explain aircraft construction
7. describe general airframe maintenance tasks.

Range/Scope/Unit content

List 1

Classification: primary, secondary and tertiary structure
Structural strength
Safe life
Fail safe
Factor of Safety
Damage tolerance
Truss
Monocoque
Semi-monocoque

List 2

Zonal systems
Airframe stations

List 3

Stress
Strain
Bending
Compression
Torsion
Tension
Hoop stress
Fatigue
Creep
Provision for systems installation

List 4

Water/Moisture traps
Drains
Contamination
Corrosion process

List 5

Methods of bonding components
Methods of dissipating static eg:
Static wicks
Bonding leads
Conductive tyres

List 6

Typical methods and components used in airframe construction eg:
Stressed skin fuselage
Formers
Stringers
Longerons
Bulkheads
Frames
Struts
Ties
Beams
Floor structures
Methods of skinning
Wing, empennage and engine attachments
Anti-corrosion protection
Pressure sealing: techniques of, and materials for, sealing between interfaying layers of skin.

List 7

Processes and procedures for eg:
Airframe inspection and testing
Repair of protective coatings
Lubrication
Structural husbandry
Maintenance information and documentation.

Unit 205 Maintaining aircraft structures

Outcome 6 Understand techniques for the assembly and repair of airframe structures and components

Assessment Criteria

The learner can:

1. describe techniques of airframe structure assembly
2. describe methods of surface cleaning and protection
3. describe airframe symmetry and alignment checks
4. explain the classification of damage to aircraft materials
5. explain visual inspection techniques
6. describe corrosion removal, assessment and re-protection methods
7. explain general contents of structural repair manuals
8. describe deterioration control programmes
9. explain non-destructive inspection techniques
10. explain disassembly and re-assembly techniques for typical airframe components.

Range/Scope/Unit content

List 1

Use of eg:
Riveting
Bonding
Threaded fasteners
Welding

List 2

Aircraft washing
Post wash lubrication
Chromating
Anodising
Painting

List 3

Symmetry
Alignment
Datum points
Clinometer checks

List 4

Metallic, composite and other aircraft materials:
Classification of damage

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

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

List 7
Eg:
Standard repair schemes
Standard techniques
Repair limits

List 8
ageing, fatigue and corrosion Eg:
Fatigue monitoring
Flying hours monitoring
Inspections
Service checks

List 9
Visual aids
Penetrant flaw detection
Magnetic particle
Eddy current
Ultrasonics
Radiography

List 10
Eg:
- Control surfaces
- Pylons
- Undercarriage leg

Using:
- Locking devices
- Jigs
- Special tools
- Materials

Unit 205 Maintaining aircraft structures

Outcome 7 Be able to use techniques for the assembly airframe structures and components

Assessment Criteria

The learner can:

1. demonstrate workplace emergency procedures
2. carry out classification of airframe structures
3. carry out routine airframe inspections
4. remove and fit typical airframe components
5. assemble sections of airframe structure.

Range/Scope/Unit content

List 1

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

List 2

Identification and classification of common airframe structures into:
Primary
Secondary
Tertiary

List 3

Visual inspection for damage, corrosion etc
Selection and use of inspection and measuring equipment
Selection of information from organisational systems eg:
Drawings, procedures, checking validity, issue number
Measurement and recording of eg:
Dimensions
Symmetry
Correct assembly
Integrity of attachments
Surface finish

List 4

Eg:
Control surfaces
Undercarriage components
Nacelles
Tool and equipment selection
Information selection
Correct use of procedures and techniques
Inspection of completed work

List 5

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

Unit 205 Maintaining aircraft structures

Outcome 8 Understand maintenance procedures for the safe and effective operation of aircraft

Assessment Criteria

The learner can:

1. describe the purpose of a Maintenance Planning department
2. explain the need for modification programmes
3. explain the process for certification and release of aircraft parts and materials
4. explain why life-limited components need to be controlled
5. describe inspection techniques used following lightning strikes and HIRF penetration
6. describe inspection techniques used following abnormal events.

Range/Scope/Unit content

List 1

Including its interface with aircraft operations
IRAN (Inspect and repair As Necessary)
Scheduled maintenance
Preventative maintenance
Anti-deterioration maintenance
Aircraft log books, documentation etc

List 2

Why modifications are needed
Typical implementation procedure
Designer modification
Service/Operator modification
Modification leaflets
Technical instructions

List 3

Documentation

List 4

Typical life-limited components
Documentation

List 5

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

List 6

Eg:

Heavy landing
Bird strike
Hail damage
Tyre burst
Brake fire
Flight through turbulence
Atmospheric contamination
Inspection techniques

Unit 205 Maintaining aircraft structures

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

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

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

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

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

Module 11.3 "Fuselage construction and pressurisation sealing" is also covered in Outcome 5 AC 6 and should be taught to EASA Level 2.

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

Unit 206 Maintaining aircraft mechanical systems

Level: 3
Credit value: 12
UAN: T/503/0986

Unit aim
The aim of this unit is to provide learners with a detailed understanding of aircraft mechanical systems. It provides knowledge and understanding for a number of NVQ Diploma units and for parts of EASA part66 Module 11A.

Learning outcomes
There are **ten** learning outcomes to this unit. The learner will:
1 understand aircraft air systems
2 understand aircraft fire protection systems
3 understand aircraft hydraulic power supply systems
4 understand aircraft flight control systems
5 understand aircraft landing gear systems
6 understand aircraft fuel system
7 understand aircraft ice and rain protection system
8 understand aircraft oxygen systems
9 understand aircraft cabin and cargo equipment and furnishings
10 be able to perform maintenance procedures on aircraft mechanical 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: multiple units

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:
- A centre set assignment covering both practical activities and underpinning knowledge.

Unit 206 Maintaining aircraft mechanical systems

Outcome 1 Understand aircraft air systems

Assessment Criteria

The learner can:

1. describe methods of supplying air for aircraft air conditioning systems
2. explain how air cycle and vapour cycle machines operate and are maintained
3. describe the distribution of air conditioning supply systems
4. explain the operation of control systems
5. explain how cockpit and cabin pressurisation systems operate and are maintained
6. describe safety and warning devices used in air conditioning systems
7. explain the sources of pneumatic/vacuum supply.
8. describe the layout of a typical pneumatic/vacuum system.

Range/Scope/Unit content

List 1

All of:
Engine bleed air
APU
Ground maintenance trolley
ECU driven compressor
RAM air

List 2

Eg:
Air cooling systems (eg: primary and secondary heat exchangers, cold air unit)
Liquid cooling systems
Refrigerant
Flight suit cooling
Safety devices
System inspection and maintenance

List 3

To include:
Air supply piping
Ducting and ducting connectors
Ducting insulation
ECU Non-return valve
Ejector shut off valves
Ejector assemblies
Pressure regulating shut off valves

List 4
For flow, temperature and humidity eg:
Temperature control valve
Humidifier
Cabin temperature sensor

List 5
Cockpit and Cabin sealing, construction and pressurisation
Doors, air-stairs and emergency exits
Windows and windscreens
Cabin pressure controllers
Pressure inwards/outwards relief valves
Ventilation
RAM air valves
Cabin pressure tests
Medical requirements for personnel

List 6
EG:
Flow, temperature and humidity control systems
Central Warning Panel
Attention getters
Alarms

List 7
Main engines,
APU
Compressor
Reservoirs
Ground supply

List 8
Installation and uses
Pressure regulation
Indications and warnings.

Unit 206 Maintaining aircraft mechanical systems

Outcome 2 Understand aircraft fire protection systems

Assessment Criteria

The learner can:

1. explain fire extinguishing systems and system tests
2. explain detection and warning systems for fire and smoke
3. describe typical aircraft portable fire extinguishers.

Range/Scope/Unit content

List 1

Nature of fire
Fire hazards
Fire extinguishing methods eg: cooling, smothering
Fire extinguishers and extinguishants
Pipelines, spray rings and nozzles
Explosion suppression systems

List 2

Fire wire
Bi-metallic heat detectors
Thermo-electric fire detector
Smoke detectors
Fire Warning panel
Attention getters
Fire buttons
Crash switches

List 3

Hand held extinguishers
Safety precautions.

Unit 206 Maintaining aircraft mechanical systems

Outcome 3 Understand aircraft hydraulic power supply systems

Assessment Criteria

The learner can:

1. describe the components of a typical aircraft hydraulic power supply system
2. describe fluids used in aircraft hydraulic systems
3. explain hydraulic reservoirs and accumulators
4. explain methods of hydraulic power generation
5. explain methods of emergency power generation
6. explain methods of controlling pressure, flow and distribution
7. explain types of hydraulic indication and warning systems used in aircraft
8. describe hydraulic power interfaces with other systems.

Range/Scope/Unit content

List 1

Brahma's press
Reservoirs
Pumps
Actuators
Pressure control
Filters
Pipes

List 2

Types of fluid (eg mineral, vegetable, synthetic)
Resistance to compression
Temperature stability
Chemical stability
Corrosive properties
Fluid/system cleanliness
Fluid contamination/decontamination procedures
Replenishment equipment and procedures
Health and Safety

List 3

Purpose and operation eg:
Storage of fluid
Storage of emergency pressure
Damping of pressure fluctuations
Gas charging

List 4
Electric, mechanical and pneumatic eg:
Engine driven hydraulic pumps, fixed displacement, self idling pumps
Electrical driven hydraulic pumps
Power transfer units
Hand operated pumps

List 5
Eg:
Ram Air turbine
Power transfer unit
Accumulator
APU

List 6
Including
Control valves
Pressure regulators
Non return valves
Shuttle valves

List 7
Pressure switches
Pressure transducers
Hydraulic pressure gauges
Central warning panel
Attention getters

List 8
Eg:
Electrical
Flight controls (auto and manual)
Cooling of hydraulics using fuel.

Unit 206 Maintaining aircraft mechanical systems

Outcome 4 Understand fixed-wing flight control systems

Assessment Criteria

The learner can:

1 describe primary and secondary controls used on an aircraft
2 explain types of flight control system operation
3 explain the operation of a manual flying control system
4 explain the operation of a powered flying control system
5 explain methods of trim control
6 explain active load control
7 describe methods of deployment of high lift devices
8 describe methods of deployment of drag inducing devices
9 describe artificial feel systems
10 explain control system balancing and rigging
11 explain stall protection/warning systems.

Range/Scope/Unit content

List 1

Eg:
Ailerons
Elevators
Rudder
Flaps
Slats

List 2

Manual
Hydraulic
Pneumatic
Electrical
Fly-by-wire
Fly-by-light

List 3

Eg:
Control Stick
Cables
Push-pull rods
Bell cranks
Turnbuckles
Pulleys
Chains
Sprockets
Torque tubes

List 4
Eg:
Hydraulic power control units
Electrical power control units
Dual hydraulic control systems
Fly-by wire systems
Fly-by-light
Feedback mechanisms

List 5
Mechanical, screw jacks, trim wheels
Electric actuators
Electronic control

List 6
Eg:
Gust alleviation
Flutter suppression

List 7
Eg:
Screw jacks
Torque tubes
Hydraulic and electric actuators
Trailing edge flaps
Krueger flaps
Slats
Boundary Layer Control

List 8
Eg:
Screw jacks
Torque tubes
Hydraulic and electric actuators
Speed brakes
Air brakes
Lift dump
Reverse thrust
Roll spoilers

List 9
Yaw damper
Mach trim
Rudder limiter

List 10
Eg:
Range of movement
Rigging pins
Gust locks
Control symmetry checks
Neutral positions
Differential movement

List 11
Including:
Load factor protection
Pitch attitude protection
High AOA protection
High speed protection.

Unit 206 Maintaining aircraft mechanical systems

Outcome 5 Understand aircraft landing gear systems

Assessment Criteria

The learner can:

1. describe the layout of typical landing gear systems
2. explain construction and methods used on aircraft landing gear
3. explain shock absorbing methods used on aircraft landing gear
4. explain landing extension and retraction systems
5. explain wheels, brakes, anti-skid and auto braking systems used on aircraft
6. describe types and construction of tyres used on aircraft landing gear
7. explain typical steering systems.

Range/Scope/Unit content

List 1

Fixed, retractable
Tail wheel, tricycle, tandem
Single wheel, double wheel, tandem wheel, bogie

List 2

Eg:
Main and nose casting
Torque links

List 3

Shock absorber type eg:
Oleo/oil with/without separator
Liquid spring
Rubber
Leaf Spring

List 4

Landing gear hydraulic system
Sequencing of retraction/extension
Retraction mechanisms
Locking mechanisms
Bracing struts
Axles
Indications and warnings
Emergency lowering

List 5
Types of wheel: material, detachable flange, split rim, wheel bearings, fusible plugs
Brake unit construction, wear limits, maintenance
Hydraulic brake systems
Emergency brake systems
Parking brake systems
Mechanical/hydraulic anti-skid
Electro-hydraulic anti-skid
Auto-brake systems (landing, take-off, intensity settings, conditions for operation)

List 6
Eg:
Bias (cross) ply
Radial ply
Tubed
Tubeless
Sidewall markings
Tread patterns
Wear limits
Damage limits (eg: oil contamination, cuts, blisters etc)

List 6
Castoring
Differential braking
Mechanical-hydraulic systems
Electro-hydraulic systems
Self centring

Unit 206 Maintaining aircraft mechanical systems

Outcome 6 Understand aircraft fuel systems

Assessment Criteria

The learner can:

1. describe the layout of a typical aircraft fuel system
2. describe the types of fuel tanks used in aircraft
3. describe a typical fuel supply system from tank to engine
4. explain fuel cross-feed, transfer and longitudinal balance systems
5. describe indication and warning systems used in fuel systems
6. explain the process of refuelling and defueling aircraft.

Range/Scope/Unit content

List 1

To include:
Fuel tanks
Collector tanks
Pipelines and couplings
Vents
Fuel/water drain points

List 2

Types of tank, bag tanks, integral tanks, external tanks
Layout and construction
Fuel tank inert gas systems
Foam fire suppressant

List 3

Pipelines and connectors
Fuel pumps
HP fuel valves
LP fuel valves
Inwards/outwards vent valves
Dumping, venting and draining

List 4

Centre of gravity
Fuel pressurisation
Transfer pumps
Float valves/switches
Reed switches
Automatic balance

List 5

To include:
Fuel gauging and capacitors
Fuel selector panels

List 6

Pressure and open line gravity refuelling
Ground refuel/defuel selector panels
Refuel/defuel connection
Bonding.

Unit 206 Maintaining aircraft mechanical systems

Outcome 7 Understand aircraft ice and rain protection systems

Assessment Criteria

The learner can:

1. explain ice formation, classification and detection
2. explain the anti-icing and de-icing systems used on aircraft
3. describe the use of windscreen ice protection, wiper systems and rain repellent.
4. describe probe and drain heating systems
5. describe indication and controls used in ice and rain protection systems

Range/Scope/Unit content

List 1

Ice formation, type and severity
Ice detectors (pressure, electro-mechanical, visual, ultrasonic)

List 2

Thermal
Mechanical
Electrical
Fluids

List 3

Fluid spray
Electrical heating
Hot air blowing
Windscreen wiper actuation (electric, hydraulic)
Windscreen cleaning
Chemical rain repellents
De-misting systems

List 4

Probe heating systems
Water drain heating

List 5

Warning systems
Cockpit indications
Control panel.

Unit 206 Maintaining aircraft mechanical systems

Outcome 8 Understand aircraft oxygen systems

Assessment Criteria

The learner can:

1 describe the layout of a typical aircraft oxygen supply system
2 describe the storage and distribution of oxygen on an aircraft
3 explain oxygen supply regulation
4 describe indication and warning systems used in oxygen systems.

Range/Scope/Unit content

List 1

Pipelines
Heat exchangers
Expansion vessels
Cylinders
Labelling

List 2

Including charging
Gaseous oxygen
Liquid oxygen
On board oxygen generation systems
Portable oxygen systems
Emergency oxygen

List 3

Pressure and flow regulators
Pressure-demand
Oxygen masks and hoses

List 4

High pressure indication
Low pressure indication
Flow and contents gauges.

Unit 206 Maintaining aircraft mechanical systems

Outcome 9 Understand aircraft cabin and cargo equipment and furnishings

Assessment Criteria

The learner can:

1 describe the layout of a typical aircraft water supply system
2 describe aircraft toilet systems
3 explain the problems of corrosion associated with aircraft toilets and galleys
4 explain the requirements for aircraft emergency equipment
5 explain typical aircraft seats, harnesses and belts
6 explain lifting systems
7 explain emergency flotation systems
8 explain typical cargo retention systems

Range/Scope/Unit content

List 1

Potable water storage
Bleed air supply
Pipeline and distribution
Water heaters
Taps, basins and drains
Fill and drain points
Venting
Valves

List 2

Waste tanks
Servicing ports
Vacuum system
Valves

List 3

Galley Installation
Organic fluids corrosion
Cleaning
Sealing

List 4

Including:
Life jackets/preservers
Medical equipment
Emergency chutes
Lighting
Escape equipment

List 5
Eg:
Seats
Seat belts
Seat harnesses
Sky cots
Cabin Entertainment Displays and associated Equipment

List 6
Hoists
Winches
Lifts

List 7
Aircraft flotation

List 8
Cabin and cargo hold layout including:
Ball and roller
Cargo nets
Attachment points
Luggage boxes
Pallets
Containers.

Unit 206 Maintaining aircraft mechanical systems

Outcome 10 Be able to perform maintenance procedures on aircraft mechanical systems.

Assessment Criteria

The learner can:

1. perform typical maintenance operation on an aircraft mechanical system
2. perform removal and fit of aircraft mechanical components.

Range/Scope/Unit content

List 1

Eg:
Replenishment
Inspection
Adjustment
Lubrication
Of eg:
Undercarriage
Flying controls
Air and oxygen systems
Hydraulic systems
Seats and harnesses

List 2

Replacement of eg:
Brake pack
Retraction jack
Nose wheel door
Nose wheel steering motor
Equipment and furnishings
Seats
Restraints
Trims

Unit 206 Maintaining aircraft mechanical 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 the Mechanical Systems part of the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 11A – The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

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

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

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

Outcome 1: EASA Level 3
Outcome 2: EASA Level 3 (Except 3 (EASA Level 1))
Outcome 3: EASA Level 3
Outcome 4: EASA Level 3
Outcome 5: EASA Level 3
Outcome 6: EASA Level 3
Outcome 7: EASA Level 3
Outcome 8: EASA Level 3
Outcome 9: EASA Level 3 (except 1 and 2 (EASA Level 2))
Outcome 10: EASA Level 3

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

Note: the 'ATA' references in the outcome titles refer to chapters in the standard Air transport Association of America (ATA) aircraft maintenance manual template in general use throughout the civilian aviation industry.

Unit 207 Maintaining gas turbine engines and propellers

Level: 3
Credit value: 15
UAN: A/503/1195

Unit aim

This unit aims to provide learners with a detailed understanding of Gas Turbine Engines fitted to rotary and fixed wing aircraft, together with propeller assemblies. The unit also offers associated practical skills. The unit covers the complete syllabi for EASA Part-66 Modules 14 for Category B2 and 15 and 17 for category B1 licences.

Learning outcomes

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

1. understand the fundamentals of gas turbine engine theory
2. understand inlets and compressors
3. understand combustion, turbine and exhaust sections
4. understand lubrication and fuel systems
5. understand starting, ignition, air and power augmentation systems
6. know engine indication and protection systems
7. understand types of aircraft gas turbine engine installations
8. understand propellers and propeller systems
9. understand engine ground operation, monitoring and storage
10. be able to undertake practical tasks on aircraft equipment.

Guided learning hours

It is recommended that **120** hours should be allocated for this unit. This may be on a full-time or part-time basis.

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

This unit is linked to the Aeronautical Engineering Level 3 NOS Units 143, 152 etc.

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:

- A centre set assignment covering both practical activities and underpinning knowledge.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 1 Understand the fundamentals of gas turbine engine theory

Assessment Criteria

The learner can:

1. explain energy and Newton's Laws of Motion
2. explain the Brayton cycle
3. explain the relationship between force, work, power, energy, velocity, and acceleration
4. explain terms relating to gas turbine engine performance
5. explain engine efficiencies
6. explain by-pass and engine pressure ratio
7. explain pressure, temperature and velocity of the gas flow
8. explain engine ratings
9. explain the constructional arrangement of turbo-jet and turbofan engines
10. describe the features bearings and seals used in gas turbine engines.

Range/Scope/Unit content

List 1

Potential and Kinetic energy
Force, mass, acceleration, inertia, momentum
Continuity equation
Bernoulli's equation
Local speed of sound

List 2

Constant pressure cycle (Brayton cycle)

List 3

Newton's Laws of motion
Work done
Thrust equations
Factors affecting thrust

List 4

Gross thrust, net thrust, choked nozzle thrust, thrust distribution, resultant thrust
Thrust horsepower, equivalent shaft horsepower and specific fuel consumption
International Standard Atmosphere
Thrust equations
Thrust in flight
Momentum drag
Specific fuel consumption
Power to weight ratio
Nozzle
Convergent-divergent nozzles

List 5
Propulsive efficiency
Thermal efficiency
Mass airflow

List 6
Mass airflow
Bypass airflow
Engine pressure ratio
Core gas generator
Temperature, density,

List 7
Boyle's law
Charles' law
Ideal Gas law

List 8
Static thrust
Influence of speed, altitude climate on performance
Altitude; fall in ambient air pressure/density
Temperature: increase/reduction in air density
Flat rating and limitations
ISA correction
RPM/Temperature limitation
Factors affecting thrust:-
Fuel consumption and power to weight ratio

List 9
Thrust producing engines – Turbojet/turbofan
Single and twin spool engines
Low and high bypass turbofan

List 10
Construction and performance of eg:
Ball/Roller/Squeeze film bearings
Axial loadings
Ring seals
Hydraulic seals
Brush seals
Labyrinth seals
Bearing chambers
Carbon seals
Air blown seals.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 2 Understand inlets and compressors

Assessment Criteria

The learner can:

1. describe compressor inlet ducts
2. explain the effects of various inlet configurations
3. describe inlet ice protection
4. explain axial and centrifugal compressors
5. explain compressors
6. explain fan balancing
7. explain how a compressor operates
8. explain compressor stall and surge
9. explain methods of air flow control
10. explain compressor ratio.

Range/Scope/Unit content

List 1

Ram effect
Diffuser
Kinetic energy
Pressure energy

List 2

Pod, side, bifurcated, chin, subsonic, supersonic
Shock waves
Boundary layer devices

List 3

Electrical heating system
Hot air system

List 4

Purpose
Requirements
Types:- Single, twin and multi-spool compressors

List 5
Constructional features, operating principles and applications:
Impeller, diffuser, casing (Centrifugal)
Operation, construction
Axial flow: operation
Construction:
Rotors, Rotor blades, Stator vanes
Blade attachment methods
Materials
Forging
Airflow pressure and velocity
Kinetic energy
Inlet/outlet guide vanes

List 6
Static balancing
Dynamic balancing
Blade moment weight

List 7
Airflow
Temperature
Pressure
Velocity
Optimum efficiency/Design point
Compressor characteristics

List 8
Causes and effects of:
Blade stall
Engine surge

List 9
Including:
Bleed valve systems
Variable inlet guide vanes
Variable and rotating stator vanes

List 10
Inlet pressure and temperature
Exit pressure and temperature.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 3 Understand combustion, turbine and exhaust sections

Assessment Criteria

The learner can:

1. describe the construction of a typical combustion section
2. explain the principle of operation of a typical combustion section
3. describe types of turbine blade
4. describe blade to disk attachment
5. describe nozzle guide vanes
6. explain the process of turbine blade stress and creep
7. describe the constructional features of a typical exhaust section
8. describe the principle of operation of a typical exhaust section
9. describe engine noise reduction methods
10. describe thrust reversers.

Range/Scope/Unit content

List 1

Purpose/requirements
Materials
Combustion chamber inner and outer cases
Multiple, tubo-annular or cannular, annular and reverse flow annular chambers

List 2

Fuel/Air ratio
Calorific value
Airflow diverter
Primary, secondary and tertiary air
Simplex, duplex and spray nozzle atomisers
Vaporisers
Drain/dump valves

List 3

Construction, operation and characteristics:
Materials and manufacture
Impulse
Reaction
Impulse/reaction/radial inflow
Blade twist/Shrouds

List 4

Fir tree root
BLISK bonding

List 5
Purpose
Shrouded vanes

List 6
Causes and effects:
Temperature
Extended high power
Erosion
Rate of acceleration
Run down times
Performance loss

List 7
Materials
Jet pipe/Exhaust unit/Propelling nozzle

List 8
Velocity
Mass airflow
Temperature
Low and high by-pass ratio
Convergent, divergent and variable area nozzles
Thrust vectoring

List 9
Noise suppression
Exhaust design
Acoustic shields/blankets

List 10
Eg:
High by-pass ratio fan engine
Clamshell deflector doors
Bucket target system.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 4 Understand lubrication and fuel systems

Assessment Criteria

The learner can:

1. explain the properties of gas turbine lubricants
2. describe the layout, operation and components in a typical lubrication system
3. describe the properties of gas turbine fuels
4. describe the properties and uses of fuel additives
5. describe the operation of engine control and fuel metering systems
6. describe electronic engine control (FADEC)
7. describe typical fuel system components and layout.
8. describe safety precautions applicable to lubricants and fuels.

Range/Scope/Unit content

List 1

Viscosity
Specification/Classification
Synthetic oil

List 2

Wet sump, dry sump
Pressure relief valve system
Scavenge system
Full flow system
Total loss system
Oil tanks
Oil filters
Oil pumps - pressure, scavenge
Oil coolers - air cooled, fuel cooled
Venting/Centrifugal breather
Contamination

List 3

Viscosity
Calorific value
Specific gravity
Vapour locking and boiling
Contamination

List 4
Eg:
Anti icing additives
Biocides
Antistatic agents
Antioxidants

List 5
Typical systems eg:
Hydro-mechanical flow control
Electronic flow control
Low pressure element – LP cock, LP pump, LP filter
High pressure element – HP cock, HP pump, HP pump
Fuel control unit (FCU)

List 6
Supervisory control
Full authority control
Analogue control
Digital control
Fuel metering unit

List 7
Fuel pumps
Filters
Fuel and flow control
Fuel spray nozzles

List 8
Fire
Contamination
Viscosity comparator
Water sediment
Bacterial Growth (Cladisporium Resinae)

Unit 207 Maintaining gas turbine engines and propellers

Outcome 5 Understand starting, ignition, air and power augmentation systems

Assessment Criteria

The learner can:

1. describe the operation of engine start systems
2. describe ignition systems and components
3. describe maintenance safety requirements
4. describe the operation of engine air distribution and anti-ice controls
5. explain the need for power augmentation
6. describe water injection systems
7. describe afterburner systems.

Range/Scope/Unit content

List 1

Purpose/requirements and components
Electric
Air turbo
Gas turbine starter/APU
Secondary power system
Hydraulic

List 2

High energy ignition unit
Igniter plug

List 3

High energy ignition units
Electrical systems safe
Systems isolation
Oil and fuel contact and spillage
Air intake and exhaust checks

List 4

Compressor/shaft cooling
Turbine cooling
Combustion cooling
Bearing chamber cooling/sealing
Accessory cooling
Exhaust cooling
Regulated/unregulated anti icing
External air services

List 5
Including typical applications
Purpose of thrust augmentation
When it might be used

List 6
Water/methanol mixture
Combustion chamber injection
Compressor injection

List 7
Principle of operation
Construction
Requirements
Methods of ignition
Methods of control

Unit 207 Maintaining gas turbine engines and propellers

Outcome 6 Know engine indication and protection systems

Assessment Criteria

The learner can:

1. describe inter-stage turbine and exhaust gas temperature systems
2. describe engine thrust indication
3. describe oil pressure and temperature indication
4. describe fuel pressure and flow indication
5. describe engine speed indication
6. describe vibration measurement and indication
7. describe torque indication
8. describe power indication
9. describe the operation of engine fire detection and extinguishing systems.

Range/Scope/Unit content

List 1

Thermocouples
Pyrometers
Exhaust Gas temperature, turbine gas temperature
Sensors

List 2

Engine pressure ratio
Engine turbine discharge pressure
RPM
Torque

List 3

Pressure/Temperature sensors and transmitters

List 4

Fuel flow transmitter
Fuel pressure transmitter
Indicator

List 5

RPM indicators
Phonic wheel
Tacho-generators

List 6
Vibration transmitter/transducers
Indicator

List 7
Torque meter
Torque sensor

List 8
Power checks
Hover performance
ISA corrected performance data (Placard)
Power performance indicators
Efficiency run

List 9
Engine cooling and ventilation
Fireproof bulkheads and cowlings
Cowling drains
Fire detectors and sensors
Fire extinguishants
Engine overheat detection.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 7 Understand the types of aircraft gas turbine engine and their installations

Assessment Criteria

The learner can:

1. explain the basic constructional arrangement of torque-producing engines
2. describe gas coupled, free turbine and gear coupled turbines
3. describe turboprop reduction gear
4. describe integrated engine and propeller controls
5. describe overspeed safety devices.
6. describe turboshaft arrangements
7. explain the operation of a typical APU
8. describe the configuration of typical engine installations.

Range/Scope/Unit content

List 1

Torque producing engines:
Turboprop
Turboshaft

List 2

Flexibility
Ease of starting
Acceleration

List 3

Epicyclic/spur gearbox

List 4

Two lever control system layout and function.
Single lever control system layout and function.

List 5

Speed governor/limiter systems

List 6

Drive systems, reduction gearing, couplings and control systems:
Types of gearboxes/gears
Types of clutches
Types of drive shafts

List 7

Purpose and description
Simple APU
Complex APU
Outputs
Over-speed
Over-temperature
Low oil
Fire detection

List 8

Thrust-producing and torque-producing:
Firewalls, cowlings, acoustic panels, engine mounts, anti-vibration mounts, hoses, pipes, feeders, control cables and rods, lifting points
Air intakes, jet pipe mountings, engine cowlings,
Fuel connections
Mechanical control rods and cables
Electrical cables, connectors and looms
Accessory drives
Fuel and oil drains
Engine lifting points.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 8 Understand propellers and propeller systems

Assessment Criteria

The learner can:

1. explain the fundamentals of propeller theory
2. describe the construction of typical propellers and their principles of operation
3. describe the principles of propeller pitch control
4. describe propeller ice protection
5. describe typical maintenance operations on propellers
6. describe how propellers are stored.

Range/Scope/Unit content

List 1

Blade element theory
High, low and reverse angle of attack
Rotational speed
Propeller slip
Aerodynamic centrifugal and thrust forces
Torque
Relative airflow on blade angle of attack
Vibration and resonance

List 2

For typical propeller types including:
Materials for composite and metal blades
Position of blade station, blade face, blade shank and hub assembly
Assembly of fixed, variable and constant speed propellers
Propeller and spinner installation

List 3

Speed control and pitch change methods
Feathering and reverse pitch
Overspeed protection

List 4

Fluid and electrical

List 5

Scheduled and unscheduled:
Static and dynamic balancing
Blade tracking
Assessment of blade damage: erosion, corrosion, delamination, impact damage
Propeller treatment and repair schemes - overview
Propeller engine running

List 6

Preservation and recovery from preservation.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 9 Understand engine ground operation, monitoring and storage

Assessment Criteria

The learner can:

1. describe typical procedures for starting and ground run-up
2. explain the interpretation of engine power output and parameters
3. describe trend monitoring processes
4. describe inspection methods for engines and components
5. describe compressor washing/cleaning
6. explain how foreign object damage is caused
7. describe preservation and recovery methods for engines and accessories
8. describe typical scheduled and unscheduled maintenance operations on gas turbine engines.

Range/Scope/Unit content

List 1

Purpose
Ground running danger zones
Wet run/Dry run
Normal start
Ignition checks

List 2

Limitations
Starting/running
Performance checks

List 3

Purpose of trend monitoring
Typical methods eg:
Engine usage monitoring system
Low cycle fatigue
Magnetic chip detectors
Oil sampling
Borescope inspection

List 4

To criteria, tolerances and data specified by the engine manufacturer:
Typical inspection process
Typical damage assessment
Blade blending
Engine handing

List 5
Purpose
Gas path erosion
Performance loss
Fluid cleaning
Abrasive grit cleaning

List 6
Types of damage
Typical location of damage
Effects: Loss of performance/imbalance failure
Actions:
Repair/assessment/limitation
Blade weighing
Repair/replacement

List 7
Purpose
Short term storage
Long term storage
Bungs, blanks and covers
Fuel system inhibiting
Oil system inhibiting
Water vapour resistant bags
Liquid protective barrier

List 8
Eg: filter, magnetic chip change
Replenishment
Lubrication
Borescope and other inspections.

Unit 207 Maintaining gas turbine engines and propellers

Outcome 10 Be able to perform routine inspection and maintenance.

Assessment Criteria

The learner can:

1. perform scheduled and un-scheduled maintenance tasks on gas turbine engines.

Range/Scope/Unit content

List 1

Engine eg: |
Filter, magnetic chip change
Replenishment
Lubrication
Inspection
Replacement of external components

Unit 207 Maintaining gas turbine engines and propellers

Notes for guidance

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

This unit contains the complete syllabi of EASA 2042/2003 part 66 Basic Knowledge Requirements Module14 – Propulsion (Cat B2), Module 15 – Gas Turbine Engine and Module 17 - Propeller. The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

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

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

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

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 2
Outcome 4: EASA Level 2
Outcome 5: EASA Level 2 (except 5, 6 and 7- EASA Level 1)
Outcome 6: EASA Level 2
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 3 (except 7&8 – EASA Level 2)
Outcome 10: EASA Level 2

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

Unit 215 Aviation mathematics and science for technicians

Level: 3
Credit value: 8
UAN: R/503/0980

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

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 ρp = 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.

Unit 216 Maintaining gas turbine engines and rotors

Level: 3
Credit value: 15
UAN: H/503/1150

Unit aim

This unit aims to provide learners with a detailed understanding of Gas Turbine Engines fitted to rotary and fixed wing aircraft, together with helicopter rotor assemblies. The unit also offers associated practical skills. It covers the complete syllabi for EASA Part-66 Modules 14 for Category B2, Module 15 and parts of Module 12 for category B1 licences.

Learning outcomes

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

1. understand the fundamentals of gas turbine engine theory
2. understand inlets and compressors
3. understand combustion, turbine and exhaust sections
4. understand lubrication and fuel systems
5. understand starting, ignition, air and power augmentation systems
6. understand engine indication and protection systems
7. understand the types of aircraft gas turbine engine and their installations
8. understand rotor heads and blades
9. understand engine ground operation, monitoring and storage
10. be able to carry out routine inspection and maintenance.

Guided learning hours

It is recommended that **120** 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 145, 168 etc

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:

- A centre set assignment covering both practical activities and underpinning knowledge.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 1 Understand the fundamentals of gas turbine engine theory

Assessment Criteria

The learner can:

1. explain energy and Newton's Laws of Motion
2. explain the Brayton cycle
3. explain the relationship between force, work, power, energy, velocity, and acceleration
4. explain terms relating to gas turbine engine performance
5. explain engine efficiencies
6. explain by-pass and engine pressure ratio
7. explain pressure, temperature and velocity of the gas flow
8. explain engine ratings
9. explain the constructional arrangement of turbo-jet and turbofan engines
10. describe the features bearings and seals used in gas turbine engines.

Range/Scope/Unit content

List 1

Potential and Kinetic energy
Force, mass, acceleration, inertia, momentum
Continuity equation
Bernoulli's equation
Local speed of sound

List 2

Constant pressure cycle (Brayton cycle)

List 3

Newton's Laws of motion
Work done
Thrust equations
Factors affecting thrust

List 4

Gross thrust, net thrust, choked nozzle thrust, thrust distribution, resultant thrust
Thrust horsepower, equivalent shaft horsepower and specific fuel consumption
International Standard Atmosphere
Thrust equations
Thrust in flight
Momentum drag
Specific fuel consumption
Power to weight ratio
Nozzle
Convergent-divergent nozzles

List 5
Propulsive efficiency
Thermal efficiency
Mass airflow

List 6
Mass airflow
Bypass airflow
Engine pressure ratio
Core gas generator
Temperature, density,

List 7
Boyle's law
Charles' law
Ideal Gas law

List 8
Static thrust
Influence of speed, altitude climate on performance
Altitude; fall in ambient air pressure/density
Temperature: increase/reduction in air density
Flat rating and limitations
ISA correction
RPM/Temperature limitation
Factors affecting thrust:-
Fuel consumption and power to weight ratio

List 9
Thrust producing engines – Turbojet/turbofan
Single and twin spool engines
Low and high bypass turbofan

List 10
Construction and performance of eg:
Ball/Roller/Squeeze film bearings
Axial loadings
Ring seals
Hydraulic seals
Brush seals
Labyrinth seals
Bearing chambers
Carbon seals
Air blown seals.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 2 Understand inlets and compressors

Assessment Criteria

The learner can:

1. describe compressor inlet ducts
2. explain the effects of various inlet configurations
3. describe inlet ice protection
4. explain axial and centrifugal compressors
5. explain compressors
6. explain fan balancing
7. explain how a compressor operates
8. explain compressor stall and surge
9. explain methods of air flow control
10. explain compressor ratio.

Range/Scope/Unit content

List 1

Ram effect
Diffuser
Kinetic energy
Pressure energy

List 2

Pod, side, bifurcated, chin, subsonic, supersonic
Shock waves
Boundary layer devices

List 3

Electrical heating system
Hot air system

List 4

Purpose
Requirements
Types:- Single, twin and multi-spool compressors

List 5
Constructional features, operating principles and applications:
Impeller, diffuser, casing (Centrifugal)
Operation, construction
Axial flow: operation
Construction:
Rotors, Rotor blades, Stator vanes
Blade attachment methods
Materials
Forging
Airflow pressure and velocity
Kinetic energy
Inlet/outlet guide vanes

List 6
Static balancing
Dynamic balancing
Blade moment weight

List 7
Airflow
Temperature
Pressure
Velocity
Optimum efficiency/Design point
Compressor characteristics

List 8
Causes and effects of:
Blade stall
Engine surge

List 9
Including:
Bleed valve systems
Variable inlet guide vanes
Variable and rotating stator vanes

List 10
Inlet pressure and temperature
Exit pressure and temperature.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 3 Understand combustion, turbine and exhaust sections

Assessment Criteria

The learner can:

1. describe the construction of a typical combustion section
2. explain the principle of operation of a typical combustion section
3. describe types of turbine blade
4. describe blade to disk attachment
5. describe nozzle guide vanes
6. explain the process of turbine blade stress and creep
7. describe the constructional features of a typical exhaust section
8. describe the principle of operation of a typical exhaust section
9. describe engine noise reduction methods
10. describe thrust reversers.

Range/Scope/Unit content

List 1

Purpose/requirements
Materials
Combustion chamber inner and outer cases
Multiple, tubo-annular or cannular, annular and reverse flow annular chambers

List 2

Fuel/Air ratio
Calorific value
Airflow diverter
Primary, secondary and tertiary air
Simplex, duplex and spray nozzle atomisers
Vaporisers
Drain/dump valves

List 3

Construction, operation and characteristics:
Materials and manufacture
Impulse
Reaction
Impulse/reaction/radial inflow
Blade twist/Shrouds

List 4

Fir tree root
BLISK bonding

List 5
Purpose
Shrouded vanes

List 6
Causes and effects:
Temperature
Extended high power
Erosion
Rate of acceleration
Run down times
Performance loss

List 7
Materials
Jet pipe/Exhaust unit/Propelling nozzle

List 8
Velocity
Mass airflow
Temperature
Low and high by-pass ratio
Convergent, divergent and variable area nozzles
Thrust vectoring

List 9
Noise suppression
Exhaust design
Acoustic shields/blankets

List 10
Eg:
High by-pass ratio fan engine
Clamshell deflector doors
Bucket target system.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 4 Understand lubrication and fuel systems

Assessment Criteria

The learner can:

1. explain the properties of gas turbine lubricants
2. describe the layout, operation and components in a typical lubrication system
3. describe the properties of gas turbine fuels
4. describe the properties and uses of fuel additives
5. describe the operation of engine control and fuel metering systems
6. describe electronic engine control (FADEC)
7. describe typical fuel system components and layout.
8. describe safety precautions applicable to lubricants and fuels.

Range/Scope/Unit content

List 1

Viscosity
Specification/Classification
Synthetic oil

List 2

Wet sump, dry sump
Pressure relief valve system
Scavenge system
Full flow system
Total loss system
Oil tanks
Oil filters
Oil pumps - pressure, scavenge
Oil coolers - air cooled, fuel cooled
Venting/Centrifugal breather
Contamination

List 3

Viscosity
Calorific value
Specific gravity
Vapour locking and boiling
Contamination

List 4
Eg:
Anti icing additives
Biocides
Antistatic agents
Antioxidants

List 5
Typical systems eg:
Hydro-mechanical flow control
Electronic flow control
Low pressure element – LP cock, LP pump, LP filter
High pressure element – HP cock, HP pump, HP pump
Fuel control unit (FCU)

List 6
Supervisory control
Full authority control
Analogue control
Digital control
Fuel metering unit

List 7
Fuel pumps
Filters
Fuel and flow control
Fuel spray nozzles

List 8
Fire
Contamination
Viscosity comparator
Water sediment
Bacterial Growth (Cladisporium Resinae)

Unit 216 Maintaining gas turbine engines and rotors

Outcome 5 Understand starting, ignition, air and power augmentation systems

Assessment Criteria

The learner can:

1. describe the operation of engine start systems
2. describe ignition systems and components
3. describe maintenance safety requirements
4. describe the operation of engine air distribution and anti-ice controls
5. explain the need for power augmentation
6. describe water injection systems
7. describe afterburner systems.

Range/Scope/Unit content

List 1

Purpose/requirements and components
Electric
Air turbo
Gas turbine starter/APU
Secondary power system
Hydraulic

List 2

High energy ignition unit
Igniter plug

List 3

High energy ignition units
Electrical systems safe
Systems isolation
Oil and fuel contact and spillage
Air intake and exhaust checks

List 4

Compressor/shaft cooling
Turbine cooling
Combustion cooling
Bearing chamber cooling/sealing
Accessory cooling
Exhaust cooling
Regulated/unregulated anti icing
External air services

List 5
Including typical applications
Purpose of thrust augmentation
When it might be used

List 6
Water/methanol mixture
Combustion chamber injection
Compressor injection

List 7
Principle of operation
Construction
Requirements
Methods of ignition
Methods of control

Unit 216 Maintaining gas turbine engines and rotors

Outcome 6 Understand engine indication and protection systems

Assessment Criteria

The learner can:

1. describe inter-stage turbine and exhaust gas temperature systems
2. describe engine thrust indication
3. describe oil pressure and temperature indication
4. describe fuel pressure and flow indication
5. describe engine speed indication
6. describe vibration measurement and indication
7. describe torque indication
8. describe power indication
9. describe the operation of engine fire detection and extinguishing systems.

Range/Scope/Unit content

List 1

Thermocouples
Pyrometers
Exhaust Gas temperature, turbine gas temperature
Sensors

List 2

Engine pressure ratio
Engine turbine discharge pressure
RPM
Torque

List 3

Pressure/Temperature sensors and transmitters

List 4

Fuel flow transmitter
Fuel pressure transmitter
Indicator

List 5

RPM indicators
Phonic wheel
Tacho-generators

List 6
Vibration transmitter/transducers
Indicator

List 7
Torque meter
Torque sensor

List 8
Power checks
Hover performance
ISA corrected performance data (Placard)
Power performance indicators
Efficiency run

List 9
Engine cooling and ventilation
Fireproof bulkheads and cowlings
Cowling drains
Fire detectors and sensors
Fire extinguishants
Engine overheat detection.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 7 Understand the types of aircraft gas turbine engine and their installations

Assessment Criteria

The learner can:

1. explain the basic constructional arrangement of torque-producing engines
2. describe gas coupled, free turbine and gear coupled turbines
3. describe turboprop reduction gear
4. describe integrated engine and propeller controls
5. describe overspeed safety devices.
6. describe turboshaft arrangements
7. explain the operation of a typical APU
8. describe the configuration of typical engine installations.

Range/Scope/Unit content

List 1

Torque producing engines:
Turboprop
Turboshaft

List 2

Flexibility
Ease of starting
Acceleration

List 3

Epicyclic/spur gearbox

List 4

Blade element theory
Blade pitch
Feathering
Reverse pitch
Propeller pitch control systems

List 5

Speed governor/limiter systems

List 6

Drive systems, reduction gearing, couplings and control systems:
Types of gearboxes/gears
Types of clutches
Types of drive shafts

List 7

Purpose and description
Simple APU
Complex APU
Outputs
Over-speed
Over-temperature
Low oil
Fire detection

List 8

Thrust-producing and torque-producing:
Firewalls, cowlings, acoustic panels, engine mounts, anti-vibration mounts, hoses, pipes, feeders, control cables and rods, lifting points
Air intakes, jet pipe mountings, engine cowlings,
Fuel connections
Mechanical control rods and cables
Electrical cables, connectors and looms
Accessory drives
Fuel and oil drains
Engine lifting points.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 8 Understand rotor heads and blades

Assessment Criteria

The learner can:

1. explain the lift produced by rotor blades
2. describe the construction of typical rotor blades
3. describe the construction of types of rotor head
4. describe types of tail rotor
5. describe rotor blade ice protection
6. describe typical maintenance operations on rotor heads and blades
7. describe how rotor blades are stored.

Range/Scope/Unit content

List 1

Eg:
Blade profile
Coriolis Effect
Magnus Effect
Bernoulli's Principle
Blade angle
Rotation speed
Effects of gyroscopic precession;
Torque reaction and directional control;
Dissymmetry of lift,
Blade tip stall
Translating tendency and its correction
Coriolis Effect and compensation
Vortex ring state, power settling, overpitching
Auto-rotation;
Ground effect

List 2

Eg:
Composite
Honeycomb

List 3

Eg:
Rigid
Semi-rigid
Fully articulated
Swash plate
Dampers
Blade attachments
Actuators

List 4
Eg:
Open anti-torque rotor
Closed 'Fenestron' rotor

List 5
Eg:
Electrical
Chemical

List 6
Eg:
Scheduled and unscheduled:
Static and dynamic balancing
Blade tracking
Assessment of blade damage: erosion, corrosion, delamination, impact damage
Inspection of rotor head components
Lubrication
Replacement of components

List 7
Eg:
Preservation and recovery from preservation
Covers
Storage racks
Climate control.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 9 Understand engine ground operation, monitoring and storage

Assessment Criteria

The learner can:

1. describe typical procedures for starting and ground run-up
2. explain the interpretation of engine power output and parameters
3. describe trend monitoring processes
4. describe inspection methods for engines and components
5. describe compressor washing/cleaning
6. explain how foreign object damage is caused
7. describe preservation and recovery methods for engines and accessories
8. describe typical scheduled and unscheduled maintenance operations on gas turbine engines.

Range/Scope/Unit content

List 1

Purpose
Ground running danger zones
Wet run/Dry run
Normal start
Ignition checks

List 2

Limitations
Starting/running
Performance checks

List 3

Purpose of trend monitoring
Typical methods eg:
Engine usage monitoring system
Low cycle fatigue
Magnetic chip detectors
Oil sampling
Borescope inspection

List 4

To criteria, tolerances and data specified by the engine manufacturer:
Typical inspection process
Typical damage assessment
Blade blending
Engine handing

List 5
Purpose
Gas path erosion
Performance loss
Fluid cleaning
Abrasive grit cleaning

List 6
Types of damage
Typical location of damage
Effects: Loss of performance/imbalance failure
Actions:
Repair/assessment/limitation
Blade weighing
Repair/replacement

List 7
Purpose
Short term storage
Long term storage
Bungs, blanks and covers
Fuel system inhibiting
Oil system inhibiting
Water vapour resistant bags
Liquid protective barrier

List 8
Eg: filter, magnetic chip change
Replenishment
Lubrication
Borescope and other inspections.

Unit 216 Maintaining gas turbine engines and rotors

Outcome 10 Be able to carry out routine inspection and maintenance

Assessment Criteria

The learner can:

1. perform scheduled and unscheduled maintenance tasks on a gas turbine engine
2. perform scheduled and unscheduled maintenance on a main rotor head and blades.

Range/Scope/Unit content

List 1

Engine eg:
Filter, magnetic chip change
Replenishment
Lubrication
Inspection
Replacement of external components

List 2

Rotor head eg:
Inspection
Test
Lubrication
Replacement of minor components
Rotor blades eg:
Inspection for impact damage, cracks, erosion, delamination etc
Minor surface maintenance
Dimensional measurement.

Unit 216 Maintaining gas turbine engines and rotors

Notes for guidance

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

This unit contains the complete syllabi of EASA 2042/2003 part 66 Basic Knowledge Requirements Module14 – Propulsion (Cat B2), Module 15 – Gas Turbine Engine and parts of Module 12 – Helicopter Aerodynamics etc. for category B1 licences

The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

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

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

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

Outcome 1: EASA Level 2
Outcome 2: EASA Level 2
Outcome 3: EASA Level 2
Outcome 4: EASA Level 2
Outcome 5: EASA Level 2 (except 5, 6, and 7 – EASA Level 1)
Outcome 6: EASA Level 2
Outcome 7: EASA Level 2
Outcome 8: EASA Level 2
Outcome 9: EASA Level 3 (except 7&8 – 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 217 Rotary wing mechanical systems and rotary wing flight controls

Level: 3

Credit value: 12

UAN: R/503/0980

Unit aim

The aim of this unit is to provide learners with a detailed understanding of aircraft mechanical systems with an emphasis on rotary wing. It provides knowledge and understanding for a number of NVQ Diploma units and for parts of EASA Part-66 Modules 11 and 12.

Learning outcomes

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

1 understand aircraft air systems
2 understand aircraft fire protection systems
3 understand aircraft hydraulic power supply systems
4 understand rotary wing flight control systems
5 understand aircraft landing gear systems
6 understand aircraft fuel system
7 understand aircraft ice and rain protection system
8 understand aircraft oxygen system
9 understand aircraft cabin and cargo equipment and furnishings
10 be able to carry out maintenance procedures on aircraft mechanical 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 147, 156 etc.

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

Key Skills

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

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

Assessment and grading

This unit will be assessed by:

- A centre set assignment covering both practical activities and underpinning knowledge.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 1 Understand aircraft air systems

Assessment Criteria

The learner can:

1. describe methods of supplying air for aircraft air conditioning systems
2. explain how air cycle and vapour cycle machines operate and are maintained
3. describe the distribution of air conditioning supply systems
4. explain the operation of control systems
5. explain how cockpit and cabin pressurisation systems operate and are maintained
6. describe safety and warning devices used in air conditioning systems
7. explain the sources of pneumatic/vacuum supply.
8. describe the layout of a typical pneumatic/vacuum system.

Range/Scope/Unit content

List 1

All of:
Engine bleed air
APU
Ground maintenance trolley
ECU driven compressor
RAM air

List 2

Eg:
Air cooling systems (eg: primary and secondary heat exchangers, cold air unit)
Liquid cooling systems
Refrigerant
Flight suit cooling
Safety devices
System inspection and maintenance

List 3

To include:
Air supply piping
Ducting and ducting connectors
Ducting insulation
ECU Non-return valve
Ejector shut off valves
Ejector assemblies
Pressure regulating shut off valves

List 4
For flow, temperature and humidity eg:
Temperature control valve
Humidifier
Cabin temperature sensor

List 5
Cockpit and Cabin sealing
Cabin pressure controllers
Pressure inwards/outwards relief valves
Ventilation
RAM air valves
Cabin pressure tests
Medical requirements for personnel

List 6
EG:
Flow, temperature and humidity control systems
Central Warning Panel
Attention getters
Alarms

List 7
Main engines,
APU
Compressor
Reservoirs
Ground supply

List 8
Installation and uses
Pressure regulation
Indications and warnings.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 2 Understand aircraft fire protection systems

Assessment Criteria

The learner can:

1. explain fire extinguishing systems and system tests
2. explain detection and warning systems for fire and smoke
3. describe typical aircraft portable fire extinguishers.

Range/Scope/Unit content

List 1

Nature of fire
Fire hazards
Fire extinguishing methods eg: cooling, smothering
Fire extinguishers and extinguishants
Pipelines, spray rings and nozzles
Explosion suppression systems

List 2

Fire wire
Bi-metallic heat detectors
Thermo-electric fire detector
Smoke detectors
Fire Warning panel
Attention getters
Fire buttons
Crash switches

List 3

Hand held extinguishers
Safety precautions.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 3 Understand aircraft hydraulic power supply systems

Assessment Criteria

The learner can:

1. describe the components of a typical aircraft hydraulic power supply system
2. describe fluids used in aircraft hydraulic systems
3. explain hydraulic reservoirs and accumulators
4. explain methods of hydraulic power generation
5. explain methods of emergency power generation
6. explain methods of controlling pressure, flow and distribution
7. explain types of hydraulic indication and warning systems used in aircraft
8. describe hydraulic power interfaces with other systems.

Range/Scope/Unit content

List 1

Brahma's press
Reservoirs
Pumps
Actuators
Pressure control
Filters
Pipes

List 2

Types of fluid (eg mineral, vegetable, synthetic)
Resistance to compression
Temperature stability
Chemical stability
Corrosive properties
Fluid/system cleanliness
Fluid contamination/decontamination procedures
Replenishment equipment and procedures
Health and Safety

List 3

Purpose and operation eg:
Storage of fluid
Storage of emergency pressure
Damping of pressure fluctuations
Gas charging

List 4
Electric, mechanical and pneumatic eg:
Engine driven hydraulic pumps, fixed displacement, self idling pumps
Electrical driven hydraulic pumps
Power transfer units
Hand operated pumps

List 5
Eg:
Ram Air turbine
Power transfer unit
Accumulator
APU

List 6
Including
Control valves
Pressure regulators
Non return valves
Shuttle valves

List 7
Pressure switches
Pressure transducers
Hydraulic pressure gauges
Central warning panel
Attention getters

List 8
Eg:
Electrical
Flight controls (auto and manual)
Cooling of hydraulics using fuel.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 4 Understand rotary wing flight control systems

Assessment Criteria

The learner can:

1. explain the principles of cyclic control
2. explain the principles of collective control
3. explain the principles of operation of a swash plate
4. explain the principles of yaw control
5. explain the design and operational features of a main rotor head
6. explain the function and construction of blade dampers
7. explain the construction and attachment of rotor blades
8. explain the construction and operation of trim control, fixed and adjustable stabilisers
9. explain the operation of flight control systems
10. explain the principles and operation of artificial feel
11. explain the principles and processes of balancing and rigging.

Range/Scope/Unit content

List 1

Detailed knowledge of: mechanical and electrical layout, control movement produced by each movement of the control, aerodynamic effect of each movement

Including grip mounted switches

Maintenance, typical faults, symptoms, causes, corrective measures

List 2

Detailed knowledge of: mechanical and electrical layout, control movement produced by each movement of the control, aerodynamic effect of each movement

Including throttle and the combined and separate effects of collective and throttle on rotor RPM and piston engine manifold pressure, function of a correlator/governor

Typical faults, symptoms, causes, corrective measures

List 3

Detailed knowledge of: purpose, design and mechanical layout, function, maintenance, typical faults, symptoms, causes, corrective measures

List 4

Detailed knowledge of: purpose, design and mechanical layout, function, maintenance, typical faults, symptoms, causes, corrective measures:

Anti-Torque Control

Tail rotor

Bleed air

List 5

Detailed knowledge of: types (fully articulated, semi-rigid, rigid); design and operation features purpose, mechanical layout, function, maintenance, typical faults, symptoms, causes, corrective measures

List 6

Detailed knowledge of: purpose, design and installation, function, maintenance, typical faults, symptoms, causes, corrective measures

List 7

Detailed knowledge of: design and installation, function, maintenance, typical faults, symptoms, causes, corrective measures:

Main and tail rotor blade construction and attachment

List 8

Detailed knowledge of: design and installation, function, maintenance, typical faults, symptoms, causes, corrective measures

List 9

Detailed knowledge of: design and installation, function, maintenance, typical faults, symptoms, causes, corrective measures

System types: manual, hydraulic, electrical and fly-by-wire

List 10

Detailed knowledge of: design and installation, function, maintenance, typical faults, symptoms, causes, corrective measures

List 11

Detailed knowledge of main rotor control system including: rigging procedure including freedom of operation, range of movement, throttle-collective correlation, synchronised elevator operation, friction

Detailed knowledge of tail rotor control system including: pedal travel, pedal alignment, T/R range of movement, cable tension, control chain twist and sprocket engagement, rod/tube adjustment.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 5 Understand aircraft landing gear systems

Assessment Criteria

The learner can:

1. describe the layout of typical landing gear systems
2. explain construction and methods used on aircraft landing gear
3. explain shock absorbing methods used on aircraft landing gear
4. explain landing extension and retraction systems
5. explain wheels, brakes, anti-skid and auto braking systems used on aircraft
6. describe types and construction of tyres used on aircraft landing gear
7. explain typical steering systems.

Range/Scope/Unit content

List 1

Fixed, retractable
Tail wheel, tricycle, tandem
Single wheel, double wheel, tandem wheel, bogie

List 2

Eg:
Main and nose casting
Torque links

List 3

Shock absorber type eg:
Oleo/oil with/without separator
Liquid spring
Rubber
Leaf Spring

List 4

Landing gear hydraulic system
Sequencing of retraction/extension
Retraction mechanisms
Locking mechanisms
Bracing struts
Axles
Indications and warnings
Emergency lowering

List 5
Types of wheel: material, detachable flange, split rim, wheel bearings, fusible plugs
Brake unit construction, wear limits, maintenance
Hydraulic brake systems
Emergency brake systems
Parking brake systems
Mechanical/hydraulic anti-skid
Electro-hydraulic anti-skid
Auto-brake systems (landing, take-off, intensity settings, conditions for operation)

List 6
Eg:
Bias (cross) ply
Radial ply
Tubed
Tubeless
Sidewall markings
Tread patterns
Wear limits
Damage limits (eg: oil contamination, cuts, blisters etc)

List 6
Castoring
Differential braking
Mechanical-hydraulic systems
Electro-hydraulic systems
Self centring

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 6 Understand aircraft fuel systems

Assessment Criteria

The learner can:

1. describe the layout of a typical aircraft fuel system
2. describe the types of fuel tanks used in aircraft
3. describe a typical fuel supply system from tank to engine
4. explain fuel cross-feed, transfer and longitudinal balance systems
5. describe indication and warning systems used in fuel systems
6. explain the process of refuelling and defueling aircraft.

Range/Scope/Unit content

List 1

To include:
Fuel tanks
Collector tanks
Pipelines and couplings
Vents
Fuel/water drain points

List 2

Types of tank, bag tanks, integral tanks, external tanks
Layout and construction
Fuel tank inert gas systems
Foam fire suppressant

List 3

Pipelines and connectors
Fuel pumps
HP fuel valves
LP fuel valves
Inwards/outwards vent valves
Dumping, venting and draining

List 4

Centre of gravity
Fuel pressurisation
Transfer pumps
Float valves/switches
Reed switches
Automatic balance

List 5
To include:
Fuel gauging and capacitors
Fuel selector panels

List 6
Pressure and open line gravity refuelling
Ground refuel/defuel selector panels
Refuel/defuel connection
Bonding.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 7 Understand aircraft ice and rain protection systems

Assessment Criteria

The learner can:

1. explain ice formation, classification and detection
2. explain the anti-icing and de-icing systems used on aircraft
3. describe the use of windscreen ice protection, wiper systems and rain repellent.
4. describe probe and drain heating systems
5. describe indication and controls used in ice and rain protection systems

Range/Scope/Unit content

List 1

Ice formation, type and severity
Ice detectors (pressure, electro-mechanical, visual, ultrasonic)

List 2

Thermal
Mechanical
Electrical
Fluids

List 3

Fluid spray
Electrical heating
Hot air blowing
Windscreen wiper actuation (electric, hydraulic)
Windscreen cleaning
Chemical rain repellents
De-misting systems

List 4

Probe heating systems
Water drain heating

List 5

Warning systems
Cockpit indications
Control panel.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 8 Understand aircraft oxygen system

Assessment Criteria

The learner can:

1 describe the layout of a typical aircraft oxygen supply system
2 describe the storage and distribution of oxygen on an aircraft
3 explain oxygen supply regulation
4 describe indication and warning systems used in oxygen systems.

Range/Scope/Unit content

List 1

Pipelines
Heat exchangers
Expansion vessels
Cylinders
Labelling

List 2

Including charging
Gaseous oxygen
Liquid oxygen
On board oxygen generation systems
Portable oxygen systems
Emergency oxygen

List 3

Pressure and flow regulators
Pressure-demand
Oxygen masks and hoses

List 4

High pressure indication
Low pressure indication
Flow and contents gauges.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 9 Understand aircraft cabin and cargo equipment and furnishings

Assessment Criteria

The learner can:

1 describe the layout of a typical aircraft water supply system
2 describe aircraft toilet systems
3 explain the problems of corrosion associated with aircraft toilets and galleys
4 explain the requirements for aircraft emergency equipment
5 explain typical aircraft seats, harnesses and belts
6 explain lifting systems
7 explain emergency flotation systems
8 explain typical cargo retention systems

Range/Scope/Unit content

List 1

Potable water storage
Bleed air supply
Pipeline and distribution
Water heaters
Taps, basins and drains
Fill and drain points
Venting
Valves

List 2

Waste tanks
Servicing ports
Vacuum system
Valves

List 3

Organic fluids corrosion
Cleaning
Sealing

List 4

Including:
Life jackets/preservers
Medical equipment
Emergency chutes
Lighting
Escape equipment

List 5
Eg:
Seats
Seat belts
Seat harnesses
Sky cots

List 6
Hoists
Winches
Lifts

List 7
Aircraft flotation

List 8
Cabin and cargo hold layout including:
Ball and roller
Cargo nets
Attachment points
Luggage boxes
Pallets
Containers.

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

Outcome 10 Be able to carry out maintenance procedures on aircraft mechanical systems.

Assessment Criteria

The learner can:

1. perform typical maintenance operation on an undercarriage system
2. perform maintenance operations on aircraft equipment and furnishings.

Range/Scope/Unit content

List 1

Replacement of eg:
Brake pack
Retraction jack
Nose wheel door
Nose wheel steering motor

List 2

Eg inspection and/or replacement of:
Seats
Restraints
Trims

Unit 217 Rotary wing mechanical systems and rotary wing flight controls

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 Mechanical Systems part of the syllabus of EASA 2042/2003 part 66 Basic Knowledge Requirements Module 11A and 12 – The equivalent EASA knowledge level indicators for each of the above outcomes - required for the B1 category - are listed below with an abridged description of each level:

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

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

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

Outcome 1: EASA Level 3
Outcome 2: EASA Level 3 (Except 3 (EASA Level 1))
Outcome 3: EASA Level 3
Outcome 4: EASA Level 3
Outcome 5: EASA Level 3
Outcome 6: EASA Level 3
Outcome 7: EASA Level 3
Outcome 8: EASA Level 3
Outcome 9: EASA Level 1 (except 1 and 2 (EASA Level 2))
Outcome 10: EASA Level 3

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

Unit 220 Fundamentals of aircraft wood and fabric maintenance

Level: 2

Credit value: 2

UAN: T/507/5894

Unit aim

The aim of this unit is to provide learners with an understanding of the maintenance of aircraft wood-and-fabric structures. The unit covers the knowledge requirement for EASA Part-66 Module 6.3.2 - Wooden structures, and 6.3.3 - Fabric covering, for Category A licences.

Learning outcomes

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

1 know how wooden airframes are constructed

2 know about aircraft fabric coverings.

Guided learning hours

It is recommended that **10** 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 Unit 013.

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

Assessment and grading

This unit will be assessed by:

- a written examination covering knowledge and understanding.

Unit 220 Fundamentals of aircraft wood and fabric maintenance

Outcome 1 Know how wooden airframes are constructed

Assessment Criteria

The learner can:

1. describe construction methods for wooden airframe structures
2. describe characteristics and properties of the types of wood and glue used in aeroplanes
3. describe methods of preserving wooden structures
4. describe methods of maintaining wooden structures
5. describe the common defects found in wood material and wooden structures
6. describe methods of detecting defects in wooden structures
7. describe methods of repairing wooden structures.

Range/Scope/Unit content

List 1

Eg:

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

List 2

Wood: type of wood used eg: spruce.

List 3

Eg:

Use of preservatives and coatings on internal members

Replacement of older glues with non-brittle epoxy.

List 4

Eg:

visual inspection and testing of glued joints, metal fittings, structural members and skin; moisture testing; inspecting fabric/wood joints for loss of adhesion.

List 5
Cross grain
Wavy curly and interlocked grain
Hard knots
Pin knot clusters
Pitch pockets
Mineral streaks
Dry rot
Wet rot
De-bonded joints
Odour from damp wood

List 6
Eg:
Borescope
Moisture tester
Acoustic test using plastic faced hammer.

List 7
Eg:
Splicing
Scarf joint
Reinforcement
Replacement
Patching (scarf, splayed, oval, plug).

Unit 220 Fundamentals of aircraft wood and fabric maintenance

Outcome 2 Know about aircraft fabric coverings

Assessment Criteria

The learner can:

1. describe characteristics, properties and types of fabric used in aeroplanes
2. describe inspection methods for fabrics
3. describe the common defects found in fabrics
4. describe common methods of repairing fabric coverings.

Range/Scope/Unit content

List 1

Eg:

Cotton, linen, Dacron, fibre glass

Classification of fabrics, stitching and lacing, anti-tear tape.

List 2

Eg:

Visual inspection, fabric punch tester; tensile testing, slackness, peeling of re-enforcing fabric from ply wood panels.

List 3

Tears, deterioration of fabric due to: humidity, extremes of temperature, chemical action, fungal growth, erosion, brittleness.

List 4

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

Appendix 1 Relationships to other qualifications

Literacy, language, numeracy and ICT skills development

This qualification can develop skills that can be used in the following qualifications:

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

Appendix 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on **www.cityandguilds.com**.

Centre Manual - Supporting Customer Excellence contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:

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

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

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

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

Access to Assessment & Qualifications provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment. The **centre homepage** section of the City & Guilds website also contains useful information such on such things as:

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

Useful contacts

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

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

About City & Guilds

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

City & Guilds Group

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

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