Pearson
BTEC

Pearson BTEC Level 3 Diploma in Air and Space Studies

Specification

BTEC Specialist qualification

First registration September 2021

About Pearson

We are the world's learning company operating in 70 countries around the world with more than 22,500 employees. We provide content, assessment and digital services to schools, colleges and universities, as well as professional and vocational education to learners to help increase their skills and lifelong employability prospects. We believe that wherever learning flourishes so do people.

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All information in this specification is correct at time of publication.

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Contents

1 Introducing the qualification

What are BTEC Specialist qualifications?

BTEC Specialist qualifications are work-related qualifications available from Entry to Level 3. The qualifications put learning into the context of the world of work, giving students the opportunity to apply their research, skills and knowledge in relevant and realistic work contexts. This applied, practical approach means learners build the knowledge, understanding and skills they need for career progression or further study.

Qualification purpose

The Pearson BTEC Level 3 Diploma in Air and Space Studies is for learners who are working in, or who are intending to work in the aviation, aerospace and engineering sectors.

The Pearson BTEC Level 3 Diploma in Air and Space Studies is suitable for learners to:

- develop knowledge related to aviation, aerospace and engineering sectors
- achieve a qualification to prepare for employment
- achieve a nationally-recognised Level 3 qualification
- develop own personal growth and engagement in learning.

Industry support and recognition

This qualification has been endorsed and is supported by the Royal Air Force (RAF) Air Cadets and has been developed alongside them.

2 Qualification summary and key information

Qualification title	Pearson BTEC Level 3 Diploma in Air and Space Studies
Qualification Number (QN)	603/7639/9
Regulation start date	01/09/2021
Operational start date	01/09/2021
Approved age ranges	16–18 18+ 19+
Total qualification time (TQT)	379 hours.
Guided learning hours (GLH)	360 hours.
Assessment	Internal assessment.
Grading information	The qualification and units are graded Pass/Fail.

Qualification title	Pearson BTEC Level 3 Diploma in Air and Space Studies
Entry requirements	Learners must be enrolled as a Royal Air Force Air Cadet. No prior knowledge, understanding, skills or qualifications are required before learners register for this qualification.
Progression	Learners who pass the Pearson BTEC Level 3 Diploma can progress to further or higher education studies in aviation, aerospace and engineering sectors. Alternatively, they may become an apprentice in a similar field or go directly to working in the RAF.

3 Qualification structure

Pearson BTEC Level 3 Diploma in Air and Space Studies

The requirements outlined in the table below must be met for Pearson to award the qualification.

Minimum number of units that must be achieved	10
Minimum number of GLH that must be achieved at Level 3 or above	360
Number of mandatory units that must be achieved	2
Number of optional units that must be achieved	8

Unit number	Mandatory units	Level	Guided learning hours
1	UK Air and Space Strategy	3	60
2	Human Factors in Aviation	3	60

Unit number	Optional units	Level	Guided learning hours
3	Aircraft Navigation Techniques	3	30
4	Principles of Airframes	3	30
5	Piston Engine Propulsion	3	30
6	Principles of Gas Turbine Propulsion	3	30
7	Space Propulsion Systems	3	30
8	Aircraft Electrical and Avionics Systems	3	30
9	Satellite Operations and Communication	3	30
10	Data Networks	3	30
11	Principles of Radio and Radar Technology	3	30
12	Space Travel	3	30
13	Cyber Security and IT	3	30

Unit number	Optional units	Level	Guided learning hours
14	Aviation Meteorology	3	30
15	Aviation Operations	3	30
16	Unmanned Aircraft Systems	3	30
17	Principles of Aircraft Flight	3	30
18	Principles of Rotorcraft	3	30
19	Space Exploration	3	30

4 Assessment requirements

The table below gives a summary of the assessment methods used in the qualification.

Units	Assessment method
All units	Internal assessment (centre-devised assessments).

Language of assessment

Learners must use English only during the assessment of this qualification.

A learner taking the qualification may be assessed in British Sign Language where it is permitted for the purpose of reasonable adjustment.

Further information on the use of language in qualifications is available in our *Use of languages in qualifications policy*, available on our website, qualifications.pearson.com.

Internal assessment

Internally assessed units are subject to standards verification. This means that centres set and mark the final summative assessment for each unit, using the examples and support that Pearson provides.

To pass each internally assessed unit, learners must:

- achieve all the specified learning outcomes
- satisfy all the assessment criteria by providing sufficient and valid evidence for each criterion
- prove that the evidence is their own.

Centres must ensure:

- assessments are marked by assessors with relevant expertise in both the occupational area and assessment. For the occupational area, this can be evidenced by a relevant qualification or current (within three years) occupational experience that is at an equivalent level or higher than this qualification. Assessment expertise can be evidenced by qualification in teaching or assessing and/or internal quality assurance or current (within three years) experience of assessing or internal verification
- internal verification systems are in place to ensure the quality and authenticity of learners' work, as well as the accuracy and consistency of assessment.

Learners who do not successfully pass an assessment are allowed to resubmit evidence for the assessment or to retake another assessment, however, items must be different and this should be evidenced as part of standards verification.

Assessment of knowledge units

To pass each knowledge unit, learners must independently complete an assessment that show that the learning outcomes and assessment criteria for the unit have been met.

Format of assessments for knowledge units:

- all learning outcomes and assessment criteria must be covered
- assessments are independently completed as a distinct activity after the required teaching has taken place
- learning outcomes must not be split into more than one assessment.
- items in the test will not necessarily be sequenced in the order of the criteria in the unit
- items in the test will not rely on or directly follow on from another test item unless explicitly specified and required.

5 Centre recognition and approval

Centres must have approval prior to delivering or assessing any of the units in this qualification.

Centres that have not previously offered BTEC Specialist qualifications need to apply for, and be granted, centre recognition as part of the process for approval to offer individual qualifications.

Guidance on seeking approval to deliver BTEC qualifications is given on our website.

Approvals agreement

All centres are required to enter into an approval agreement with Pearson, in which the head of centre or principal agrees to meet all the requirements of the qualification specification and to comply with the policies, procedures, codes of practice and regulations of Pearson and relevant regulatory bodies. If centres do not comply with the agreement, this could result in the suspension of certification or withdrawal of centre or qualification approval.

Centre resource requirements

As part of the approval process, centres must make sure that the resource requirements below are in place before offering the qualification:

- appropriate physical resources (for example IT, learning materials, teaching rooms) to support the delivery and assessment of the qualification
- suitable staff for delivering and assessing the qualification (see *Section 4 Assessment requirements*)
- systems to ensure continuing professional development (CPD) for staff delivering and assessing the qualification
- health and safety policies that relate to the use of equipment by learners
- internal verification systems and procedures (see *Section 4 Assessment requirements*)
- any unit-specific resources stated in individual units.

6 Access to qualifications

Access to qualifications for learners with disabilities or specific needs.

Equality and fairness are central to our work. Our *Equality, diversity and inclusion policy* requires all learners to have equal opportunity to access our qualifications and assessments, and that our qualifications are awarded in a way that is fair to every learner.

We are committed to making sure that:

- learners with a protected characteristic (as defined by the Equality Act 2010) are not, when they are taking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve from their qualification and that this achievement can be compared fairly to the achievement of their peers.

For learners with disabilities and specific needs, the assessment of their potential to achieve the qualification must identify, where appropriate, the support that will be made available to them during delivery and assessment of the qualification.

Centres must deliver the qualification in accordance with current equality legislation. For full details of the Equality Act 2010, please visit www.legislation.gov.uk

Reasonable adjustments and special consideration

Centres are permitted to make adjustments to assessment to take account of the needs of individual learners. Any reasonable adjustment must reflect the normal learning or working practice of a learner in a centre or a learner working in the occupational area.

Centres cannot apply their own special consideration – applications for special consideration must be made to Pearson and can be made on a case-by-case basis only.

Centres must follow the guidance in the Pearson document Guidance for reasonable adjustments and special consideration in vocational internally assessed units.

7 Recognising prior learning and achievement

Recognition of Prior Learning (RPL) considers whether a learner can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess and so do not need to develop through a course of learning.

Pearson encourages centres to recognise learners' previous achievements and experiences in and outside the workplace, as well as in the classroom. RPL provides a route for the recognition of the achievements resulting from continuous learning.

RPL enables recognition of achievement from a range of activities using any valid assessment methodology. If the assessment requirements of a given unit or qualification have been met, the use of RPL is acceptable for accrediting a unit, units or a whole qualification. Evidence of learning must be sufficient, reliable and valid.

Further guidance is available in our policy document *Recognition of prior learning policy and process*, available on our website.

8 Quality assurance of centres

For the qualification in this specification, the Pearson quality assurance model will consist of the following processes.

Centres will receive at least one visit from our Standards Verifier, followed by ongoing support and development. This may result in more visits or remote support, as required to complete standards verification. The exact frequency and duration of Standards Verifier visits/remote sampling will reflect the level of risk associated with a programme, taking account of the:

- number of assessment sites
- number and throughput of learners
- number and turnover of assessors
- number and turnover of internal verifiers
- amount of previous experience of delivery.

Following registration, centres will be given further quality assurance and sampling guidance.

For further details, please see the work-based learning quality assurance handbooks, available in the support section of our website:

- Pearson centre guide to quality assurance – NVQs/SVQs and competence-based qualifications
- Pearson delivery guidance & quality assurance requirements – NVQs/SVQs; competence-based qualifications and BTEC Specialist qualifications.

9 Units

This section of the specification contains the units that form the assessment for the qualification.

For explanation of the terms within the units, please refer to *Section 13 Glossary*.

It is compulsory for learners to meet the learning outcomes and the assessment criteria to achieve a Pass. Content is compulsory unless it is provided as an example and is therefore marked 'e.g.'. All compulsory content must be delivered, but assessments may not cover all content.

Where legislation is included in delivery and assessment, centres must ensure that it is current and up to date.

Unit 1: UK Air and Space Strategy

Level: 3

Unit type: Mandatory

Guided learning hours: 60

Unit introduction

As aircraft became more involved in military operations it quickly became apparent that a significant strategic advantage could be achieved by denying airspace to the enemy. Everyone who has studied history at school will have heard of the Battle of Britain and the efforts of the Royal Air Force in defending the UK from the aggression of the enemy. Almost daily during the Second World War, RAF planes fought intense battles over southern England to defend our skies and deny the enemy air supremacy. However, as aviation activities increased, and the use of this technology became cheaper, the skies became evermore crowded. It became apparent that the airspace needed to be policed and regulated to ensure the safety of all involved.

In this unit, you will learn about the importance of air supremacy within the battlespace. You will also learn about the role of the various UK civil and military authorities in ensuring our skies and the activities undertaken in them can be as safe as possible.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the role of UK air power and how it relates to UK National Security Strategy	1.1 Define aspects of control of the air in relation to UK air power 1.2 Describe methods of intelligence, surveillance and reconnaissance (ISR) in terms of air power 1.3 Identify different types of attack in relation to UK air power 1.4 Describe aspects of air mobility in relation to UK air power 1.5 Describe elements of the UK National Security Strategy in relation to UK air power

Learning outcomes	Assessment criteria
2. Understand the attributes of UK air power	2.1 Describe the characteristics of UK air power 2.2 Describe how elements of agility and ubiquity contribute to UK air power
3. Understand the attributes and roles of UK space power	3.1 Define attributes of UK space power 3.2 Describe aspects of the situational awareness role of UK space power 3.3 Describe aspects of the control role of UK space power 3.4 Describe aspects of the support operations of UK space power 3.5 Describe aspects of the service role of UK space power
4. Understand the role of UK aviation control and regulatory agencies	4.1 Define the term airspace 4.2 Describe aspects of the role of the Civil Aviation Authority (CAA) 4.3 Describe aspects of the role of the Military Aviation Authority (MAA) 4.4 Describe the services provided by the UK National Air Traffic Services (NATS)

Unit content

What needs to be learned
Learning outcome 1: Understand the role of UK air power and how it relates to UK National Security Strategy

1A Control of the air in relation to UK air power
• Air superiority – degree of technical advantage over your opponent.
• Air supremacy – uncontested control of the airspace over a battlefield.
• Offensive counter air – proactive attack over the enemy territory.
• Defensive counter air – reaction over enemy action over home territory.
1B Intelligence, surveillance and reconnaissance (ISR) in terms of air power
• Methods of processing:
  o categorisation of data
  o importance of data.
• Methods of exploitation:
  o shared with command structure
  o shared with allies.
• Methods of dissemination:
  o via technology, e.g. secure file transfer, radio communication, command links.
1C Different types of attack in relation to UK air power
• Strategic attack: attacking infrastructures, organisations, cyber, allies.
• Counter-land operations: air interdiction, close air support, strike, coordination and reconnaissance.
• Counter-sea operations: anti-submarine warfare and anti-surface warfare.
• Information activities: electronic warfare and psychological operations.
1D Air mobility in relation to UK air power
• Airlift: hub and spoke, aeromedical evacuation and special forces air operations.
• Airborne operations: air-to-air refuelling, paratroop deployment and air-drop.
• Peacetime rescue: natural disasters and mountain rescue.
• Recovery: personnel and combat.
1E Requirements of UK National Security Strategy that relate to UK air power
• Aspects:
  o 'Protect UK people', 'Project UK global influence' and 'Promote UK prosperity'.

What needs to be learned

- Influence:
  - hard power and soft power
  - physical, political, legal and economic aspects of UK air power.
- Components of fighting power:
  - physical: manpower, equipment and sustainment
  - moral: motivation, cohesion, leadership.

Learning outcome 2: Understand the attributes of UK air power

2A Characteristics of UK air power

- How height contributes to the attributes of UK air power:
  - how it overlays land and maritime environments
  - out of vertical range of many surface threats
  - the ability to manoeuvre in three dimensions and has enhanced survivability.
- How speed contributes to the attributes of UK air power:
  - capability for rapid attack or deployment of troops and equipment
  - capitalise on the element of surprise which reduces aircraft exposure to hostile fire.
- How reach contributes to the attributes of UK air power:
  - unimpeded by natural terrain or physical barriers
  - observe and influence operations regardless of location.

2B How agility and ubiquity contribute to UK air power

- The contribution of agility to the attributes of UK air power:
  - multi-role and multi-mission capability
  - strategic, operational or tactical flying and the ability to quickly exploit opportunity according to need.
- The contribution of ubiquity to the attributes of UK air power:
  - optimal combination of height, speed and reach
  - theoretical potential to be everywhere
  - simultaneous ability to defend and counter threat
  - ability to deliver overwhelming force when and where needed.

What needs to be learned

Learning outcome 3: Understand the attributes and roles of UK space power

3A The attributes of UK space power

- Perspective:
  - space capabilities exploit vertical dimension
  - gives military advantage of ultimate high ground.
- Access:
  - overflight of sovereign states from space not governed by international rules.
- Persistence:
  - orbit life expectancy of satellites
  - overcomes air power limitation of impermanence.
- Versatility:
  - space assets can carry out multiple roles
  - can operate across a range of government policy functions.

3B The situational awareness role of UK space power

- Detection, tracking and identification of space objects and events.
- Threat warning and attack assessment of potential and actual hazards and threats such as space weather, space debris or attacks by adversaries.
- Characterisation – using informational analysis to set the operating parameters of satellites.
- Data integration and exploitation – ability to process data from military, commercial and allied sources into a common operating picture.

3C The control role of UK space power

- Offensive space control – operations to disrupt, degrade, deny or destroy space-related capabilities and forces of adversaries.
- Defensive space control – protection of space capabilities from attack, interference or unintentional hazards.
- Passive measures of space control – protection of satellites to withstand radiation or electronic attack such as anti-jamming and cryptographic protection of command, telemetry and data transmission links.
- Active measures of space control – the use of techniques to counter adversarial jamming or interference to satellite control signals.

What needs to be learned

3D The support operations of UK space power

- Intelligence, surveillance and reconnaissance – worldwide passive imagery and electronic intelligence gathering to support military operations.
- Positioning, navigation and timing – Global Positioning System (GPS) precision navigation for military platforms and personnel, precision guidance for smart weapons and precision timing for secure communications.
- Satellite communications – the ability to communicate beyond line of sight.
- Missile warning and tracking – global coverage to track ballistic missile launches and flight paths to predict likely time and point of impact.
- Environmental monitoring – military planning information of meteorological, oceanographic and environmental factors that may affect military operations.

3E The space service support of UK space power

- Launch operations – delivery of:
  - satellites
  - payloads
  - materials.
- Satellite operations:
  - manoeuvring
  - sustainment
  - maintenance of satellites.

Learning outcome 4: Understand the role of UK aviation control and regulatory agencies

4A The current definition and categories of airspace that apply to UK aviation

- Current definition of airspace:
  - proportion of the atmosphere controlled by a country above its territory and territorial waters.
- Categories of airspace:
  - Class A, B, C, D, E, F and G.

4B The role of the Civil Aviation Authority (CAA)

- Operational approvals such as airworthiness, unmanned aircraft and registration.
- Air navigation such as radio licensing and the rules of the air.
- Operator licensing such as transporting dangerous goods.

What needs to be learned

- Aerodrome licences and safety.
- Aviation security role in compliance, regulation and security management systems.
- Applications and permissions for flying displays.
- Environmental information provision on noise, climate and air quality.
- Passenger information such as flight number, boarding information, Air Travel Organiser's Licence (ATOL) protection.
- Training and exams for aircraft engineers, cabin crew and aircrew.

4C The UK Military Aviation Authority (MAA)

- Operations: approvals, airworthiness, control of dangerous goods, leasing, unmanned aircraft and registration.
- Air navigation, radio licensing, airspace strategy and the rules of the air.
- Cabin crew and transport of dangerous goods.
- Airfield licences and safety.
- Aviation security role in compliance, regulation and security management systems.
- Applications and permissions for flying displays.
- Environmental information provision on noise, climate and air quality.

4D The services provided by the UK National Air Traffic Services (NATS)

The services provided for:

- Efficiency and safety of airport operations in the UK and overseas: airport capacity management, tower and approach, digital remote towers, digital airports and training.
- Range of safe and efficient en route services in the UK and internationally:
  - drones, airspace infringements, training and flight optimisation systems.
- Technology and engineering infrastructure:
  - control centre systems, non-directional beacon measurements, airport technology, maintenance and training.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 2: Human Factors in Aviation

Level: 3

Unit type: Mandatory

Guided learning hours: 60

Unit introduction

An understanding of human factors and behaviours in the aviation environment is essential for safe and effective working, both for individuals and for teams.

In this unit, you will be introduced to the various factors that affect human performance in the aviation environment. Also, you will develop your understanding about the potential consequences of these factors and how to take steps to prevent errors, incidents and accidents. Additionally, you will gain an understanding of the importance of human factors, features and limitations of human performance, and aspects of social psychology in an aeronautical engineering environment. Finally, you will develop an understanding of how personal factors, physical aspects of the working environment and categories of work tasks can affect human performance by studying error types, models and prevention in aeronautical engineering.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand human factors in aviation	1.1 Describe how aspects of 'human factors' are used in aviation 1.2 Identify the categories of human factors that are important in aviation 1.3 Describe elements of the UK Civil Aviation Authority's (CAA) objectives for improving human factors in aviation

Learning outcomes	Assessment criteria
2. Understand personal safety and airworthiness risks arising from limitations of human performance and working in challenging environments	2.1 Describe types of human memory limitations 2.2 Describe elements of how human memory limitation presents risk to personal safety and airworthiness 2.3 Describe types of challenging environments in aviation 2.4 Describe elements of how challenging environments present risk to personal safety and airworthiness
3. Understand personal factors that affect work performance	3.1 Identify a legal regulation for personal health and fitness in aviation 3.2 Describe how aspects of personal health and fitness affect work performance in aviation 3.3 Describe aspects of stress in a working environment 3.4 Describe elements of the effects of alcohol, medication and substance abuse on individual work performance
4. Understand how physical aspects of the working environment affect human performance	4.1 Describe how concentration and communication can be affected by aspects of the working environment
5. Understand how types of tasks can affect human performance	5.1 Identify different categories of tasks 5.2 Describe the important considerations when executing a task 5.3 Identify key aspects of working on complex systems
6. Understand the types, models and prevention of errors in aviation	6.1 Identify the types of error models used in aviation 6.2 Describe the types of errors found in aviation 6.3 Identify aspects of the error-incident-accident chain in aviation

Unit content

What needs to be learned
Learning outcome 1: Understand human factors in aviation

1A Human factors in aviation
• Definition of the term 'human factors'.
• How human factors are used in aviation:
  o SHEL (software, hardware, environment, liveware) model
  o Murphy's Law
  o anthropometry
  o Dirty Dozen – the twelve most common causes of error within aircraft maintenance
  o ergonomics.
1B The categories of human factors that are important in aviation
• Working environment.
• Work patterns.
• Social habits.
• Workload.
• Communication.
• Employee health.
• How safety relates to human factors:
  o safety of employees, passengers, people on the ground
  o safety of assets, aircraft, equipment
  o long-term health of employees.
1C The UK Civil Aviation Authority's (CAA) objectives for improving human factors in aviation
• Meaning of the CAA's statement that 'aviation is a system of systems, covering multiple interconnected activities, organisations and people'.
• The CAA's human factors objectives:
  o better use of data and information
  o embedding human factors assessment within normal oversight activities
  o supporting inspectors to develop knowledge and competencies
  o promoting best practices

What needs to be learned
○ collaborating with stakeholders and safety-critical industries ○ remaining aligned with international standards.
Learning outcome 2: Understand personal safety and airworthiness risks arising from limitations of human performance and working in challenging environments
2A Types of human memory limitations • Iconic. • Echoic. • Episodic. • Semantic. **2B Human memory limitations risks** • Time from exposure to information. • The form that information is in – audio, visual, words, pictures. • Fatigue. • Age. • Complexity of information. • Artificial memory. • Stress. • Low motivation. • Poor health. **2C Types of challenging environments** • Working at height. • Working in confined spaces. • Limited access to a large space. • Limited egress from a large space. • Uncomfortable climate. • High-speed flying manoeuvres. **2D Risks and issues within a challenging environment** • Claustrophobia. • Fear of heights.

What needs to be learned
• Low concentration. • Rushing the task. • Not following the process/full instructions. • Poor vision.
Learning outcome 3: Understand personal factors that affect work performance

3A The legal requirements and the effects that personal health and fitness have on work performance
• The legal requirement for individual physical and mental fitness while at work:
  o Military Airworthiness Authority Regulation 1440
  o Commission Regulation (EU) No 1321/2014 Annex Vc (Part-CAMO), CAMO.A.305(g).
3B Personal health and fitness factors and their associated effects on work performance
• Physical injuries such as major and minor.
• Mental health condition such as Post Traumatic Stress Disorder (PTSD).
• Gradual deterioration in physical condition such as ageing.
• Effects of toxins and other substances such as fumes from chemicals used in aircraft maintenance.
3C Stress in a working environment
• Sources of stress: home, illness, divorce, work-, organisational- or task-related.
• Types of stress: acute, chronic, hypo, hyper, eustress, distress.
• Signs of stress: physical, health, behaviour, cognitive.
3D The effects of alcohol, medication and substance abuse on individual work performance
• Effects of fatigue or hunger when combined with medication.
• Effects of short- and long-term consequences for the abuse of:
  o alcohol
  o prescription medication
  o over-the-counter medication
  o illegal drugs.

What needs to be learned
Learning outcome 4: Understand how physical aspects of the working environment affect human performance

4A Concentration and communication affected by the working environment
• Effects of:
  o noise
  o fumes
  o low oxygen levels
• Varying illumination:
  o ability to see detail
  o moving between areas of different illumination
  o strobe effect.
• Climate variations of working environments, such as cold and wet, warm and dry, hot and humid.

Learning outcome 5: Understand how types of tasks can affect human performance

5A Different categories of task
• Routine such as maintenance.
• Non-routine such as fault diagnosis.
• Repetitive such as cleaning equipment.
5B The importance of effectively executing a task
• Defining the task, the resources, the information required and allocating to the workforce.
• Effects of physical work demand in relation to:
  o health and physical condition, work environment, physical effort.
• Effects of repetitive tasks in relation to:
  o ignoring instruction manuals, complacency, making assumptions.
• Requirement for: good eyesight, subject and process knowledge, appropriate illumination, workplace concentration, systematic task completion.
5C Key aspects of working on complex systems
• Complex systems such as integrated flying controls, avionics, air conditioning systems.

What needs to be learned

• Key aspects of working on complex systems:
  o recognising the limits of own authority
  o recognising what the individual is qualified to do and when to seek advice
  o pooling of knowledge and skills
  o accessing the correct information and guidance such as maintenance manuals, technical instruction, flight reference cards.

Learning outcome 6: Understand the types, models and prevention of errors in aviation
6A The types of error models used in aviation • Induced. • Variable. • Reversible and irreversible. • Slips, lapses and mistakes. • The 'Swiss Cheese model'. **6B The types of error found in aviation** • Complacency. • Environmental capture. • Rule-based errors. • Violations. • Bad practices and habits. • Errors associated with visual inspection. • Latent and active errors. **6C The error-incident-accident chain found in aviation** • Self-discipline. • Safety management system. • Anonymous and blame-free reporting. • Training. • Logging and analysis.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 3: Aircraft Navigation Techniques

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

For aircrew, the second most important task in flying an aircraft is safely navigating it through the mission. The art of navigation as we know it today dates back centuries and the core principles have not changed. For example, Charles Lindbergh, the first person to fly across the Atlantic, used 'dead reckoning' navigation to achieve this accomplishment. This method of navigation utilises and is based on knowing how long you have been flying for, distance travelled and the direction you have travelled.

In this unit, you will consider the end-to-end process of navigation. It starts with flight planning and the plotting of the route against navigation charts and orders. At all times flight safety and aviation regulations need to be considered. Once you have looked at flight planning, you will move onto in-air navigation techniques and methodologies experienced during a typical sortie.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the importance of accurate flight planning	1.1 Describe aspects of the factors to consider when selecting an aircraft navigation chart 1.2 Describe aspects of the sources of information/resources required for accurate flight planning 1.3 Describe aspects of route plotting/chart navigation methods

Learning outcomes	Assessment criteria
2. Understand how to carry out Mental Dead Reckoning (MDR) and a route study	2.1 Describe aspects of the Mental Dead Reckoning (MDR) method for flight planning 2.2 Describe aspects of fuel planning for a navigation sortie 2.3 Describe aspects of route planning procedures/considerations
3. Understand the in-flight techniques used on a navigation sortie	3.1 Describe aspects of commencing a navigation sortie 3.2 Describe aspects of the fix point procedure 3.3 Describe aspects of the turn point procedure

Unit content

What needs to be learned
Learning outcome 1: Understand the importance of accurate flight planning
1A The factors when considering selection of an aircraft navigation chart • The 1:250,000, 1:500,000 and 1:1,000,000 scale aviation charts. • Suitability of using a 1:25,000 scale Ordnance Survey map for aircraft navigation. • Height. • Speed of transit. • Topology. **1B The different sources of information and resources required for accurate flight planning** • Equipment and stationery required for flight planning. • Acquisition and influences of meteorological information while undertaking flight planning. • Use of 'Notice to Airman' (NOTAM) when undertaking flight planning and the possible impact of the information provided in the NOTAM. • Interpretation of airfield information from a Pooleys Flight Guide and the impact this may have on flight planning. **1C Route plotting and chart navigation** • Chart information: o identification of start/turning/finish points and the method of marking them on a chart o identification of fix points and the method of marking them on a chart o the considerations when placing heading boxes on the chart o other information and annotations which are required on a chart.
Learning outcome 2: Understand how to carry out Mental Dead Reckoning (MDR) and a route study
2A Mental Dead Reckoning (MDR) method for flight planning • Use and importance of MDR during flight planning. • Extrapolate the acute wind angle (AWA) from the track and wind direction and the impact AWA will have on heading and ground speed. • Calculate the effect of different wind speeds and directions on the heading and ground speed of an aircraft flying at various indicated airspeeds.

What needs to be learned

2B Fuel planning for a navigation sortie
• The effect of fuel mass versus fuel burn rate on a large aircraft and how this impacts flight planning.
• For a navigation sortie:
  o factors to consider when developing a fuel plan such as all up weight (AUW) of the aircraft, flight distance, weather, refuelling, expected fuel usage rate
  o factors to consider when planning a diversionary or alternative airfield such as landing aid requirements, distance from intended route, runway length, facilities available.
2C Route planning procedures and considerations
• Charts required, such as Jeppersen, Aerad.
• Types of Airspace such as controlled, uncontrolled, flight information regions, upper information region.
• Airways.
• Waypoints.
• Destination and alternative suitability such as within range, compatibility with aircraft type, handling facilities available, opening times.
• Overflight and landing permissions.
• Route considerations such as most economical flight level, optimum routing, slot availability.
• Documentation required such as Notification to Airmen (NOTAM).
• Weather such as Significant Meteorological Chart (SIGMET), terminal aerodrome forecast (TAF), Meteorological terminal report (METAR).

Learning outcome 3: Understand the in-flight techniques used on a navigation sortie.
3A The process of positioning for and commencing a navigation sortie • Process of positioning for the start point. • Pre-Start checks. • Post-Start checks. • The en-route technique and the importance of flying accuracy. **3B The fix point procedure** • Process of identifying the fix point.

What needs to be learned

- Using the following methods of route correction:
  - fly to fix
  - standard closing angle
  - funnel feature.
- The re-calculating time on target and heading corrections once the fix point has been regained.

3C The turn point procedure

- Process of identifying the turn point and subsequent lead out feature.
- Pre-turn checks and turn point procedures depending on angle to be turned.
- Post-turn checks and subsequent en-route technique.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 4: Principles of Airframes

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

An understanding of airframe structures, the loads imposed on these structures and the construction, design and prevention methods used to ensure their airworthiness are of prime importance to all engineers involved with the manufacturing, production, maintenance or overhaul of aircraft airframes and/or their associated structural components.

In this unit, you will develop a general understanding of airframe structural concepts, construction and protection methods. Additionally, you will be introduced to how basic structural members and structural design concepts are used to control the loads imposed on airframe structures to ensure continued airworthiness. Finally, you will develop specific knowledge of the assembly, construction and protection methods for the aircraft fuselage, wings and ancillary structures.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand airframe loading, structural members and general structural concepts	1.1 Describe one type of airframe loading 1.2 Describe one type of structural classification for an airframe 1.3 Describe aspects of structural concepts 1.4 Describe why an airframe is checked for alignment and symmetry

Learning outcomes	Assessment criteria
2. Understand airframe general construction and protection methods	2.1 Describe aspects of aircraft construction methods 2.2 Describe an aircraft assembly technique 2.3 Describe an airframe anti-corrosion protection method
3. Understand construction and assembly of aircraft fuselage, wings and ancillary structures	3.1 Describe aspects of aircraft fuselage component assembly 3.2 Describe aspects of aircraft wing component construction 3.3 Describe aspects of aircraft ancillary structure attachment

Unit content

What needs to be learned
Learning outcome 1: Understand airframe loading, structural members and general structural concepts

1A Airframe loading
• Types of static loads applied to aircraft due to the weight of:
  o engines
  o wings
  o fuselage
  o fuel
  o external stores
  o passengers and cargo.
• Types of dynamic loads applied to aircraft including:
  o thrust
  o lift
  o weight
  o drag
  o manoeuvre
  o turbulence
  o gust.
• Types of fatigue loads applied to aircraft including:
  o those created by engine vibration
  o those created by pressure cycles and undercarriage cycles.
1B Airframe structural members and concepts
• Basic types of structural members used in aircraft construction, including struts, ties and beams.
• Typical stresses taken by structural members (tension, compression, torsion, shear, bending, hoop).
• Typical stresses taken by major structural members (such as fuselage, skin, empennage, wings, undercarriage, engine pylons).
1C Structural concepts
• Airworthiness requirements for structural strength.
• Structural classification:

What needs to be learned
○ primary such as landing gear, wings, cockpit windshields ○ secondary such as fuselage structural elements ○ tertiary such as access panels, covers, fairings. • Zonal and station identification systems. • Design concepts including: ○ failsafe ○ safe life ○ damage-tolerant structures ○ drains ○ ventilation provision ○ lightning strike protection provision ○ aircraft bonding provision. **1D Airframe symmetry and alignment checks** • Check the airframe is symmetrical about the longitudinal axis. • Check the fuselage for twist and bending. • Check vertical stabilisers for alignment. • Check wings and horizontal stabilisers for correct dihedral and incidence.
Learning outcome 2: Understand airframe general construction and protection methods
2A Aircraft construction methods • Types of construction used in aircraft manufacture including: ○ stressed skin fuselage – an aircraft construction technique where the skin carries a large portion of the imposed loads ○ stringers – thin strips of metal that run longitudinally along an aircraft fuselage or span wise along a wing that transfer the aerodynamic loads from the skin to the frames ○ longeron – run longitudinally along an aircraft fuselage to add rigidity and strength to the formers and frames. They also provide a mounting point for other structural supports ○ frames and formers – provide the shape of the fuselage and secure mounting points for other structural elements such as wings, stabilisers, powerplants ○ bulkhead – a solid frame that acts as a 'wall' within the aircraft structure

What needs to be learned
○ floor – the surface that passengers and crew walk on and also provides attachment points for furnishings ○ beams – run laterally between frames and provide support to the floor ○ struts – airframe structural components that resist and transfer compressive loads to the fuselage ○ ties – aircraft structural components that resist and transfer tensile loads to the fuselage ○ empennage – the tail section of an aircraft that comprises the vertical and horizontal stabilisers, rudder and elevators ○ engine attachments – parts of the aircraft where the engines mount. • Assembly techniques – riveting, bolting and bonding. • Anti-corrosive protection including: ○ materials selection ○ jointing compounds ○ drain holes ○ stringer design ○ chromating ○ anodising ○ painting ○ surface cleaning.
Learning outcome 3: Understand construction and assembly of aircraft fuselage, wings and ancillary structures
3A Fuselage • Construction and assembly of: ○ skin, frames, formers, longerons, pressure bulkheads, fuselage sections, wing, stabiliser, pylon, arrestor gear, undercarriage/landing gear attachments. • Construction, installation and operation of: ○ fuselage seats, cargo loading system, doors and emergency exits, door safety devices, windows and windscreens. **3B Wings** • Typical construction of wings to include: ○ stressed skin, stiffeners, spars, ribs, milled, etched, integral, wing boxes, torsion boxes, integral fuel tanks, composite bonding.

What needs to be learned
3C Ancillaries • Construction and methods of attachment of: o empennage, stabilisers, flight control surfaces, propellers, nacelles, pylons, engine mounts, firewalls.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 5: Piston Engine Propulsion

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Have you ever wondered how aircrafts are able to fly such long distances and at such speed? The answer lies in the advanced propulsion technology used in aircraft piston engine design.

In this unit, you will learn about the principles behind the operation of piston engines used to power aircraft. Additionally, you will consider how piston engines are constructed and how the different sections of the engines combine to allow power to be generated efficiently.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the design and operating cycle of a piston engine	1.1 Describe aspects of the Otto cycle 1.2 Describe aspects of piston engine configuration 1.3 Identify one requirement for an aircraft piston engine
2. Understand the construction of aircraft piston engines	2.1 Describe aspects of the construction, assembly and function of the crank case 2.2 Describe aspects of the purpose, components and operation of accessory gearboxes 2.3 Describe aspects of the construction, assembly and function of cylinders, pistons and connecting rod assemblies 2.4 Describe aspects of the construction, assembly and function of inlet and exhaust manifolds

Learning outcomes	Assessment criteria
	2.5 Describe aspects of the construction, function and operation of valve mechanisms 2.6 Describe aspects of the purpose, mounting, lubrication and faults associated with propeller reduction gearboxes
3. Understand the factors affecting piston engine power and efficiency	3.1 State two factors that will affect engine power and efficiency 3.2 Calculate aspects of measuring thermal and mechanical efficiency of a piston engine 3.3 Calculate the volumetric efficiency of a piston engine

Unit content

What needs to be learned
Learning outcome 1: Understand the design and operating cycle of a piston engine

1A The Otto cycle and terms used to describe piston engine operation
• The stages of the Otto cycle:
  o induction
  o compression
  o combustion
  o exhaust.
• Definition of the terms:
  o top dead centre (TDC)
  o bottom dead centre (BDC)
  o clearance
  o volume
  o bore
  o stroke
  o swept volume
  o firing order
  o ignition timing
  o valve timing
  o 'heat engine'
  o 'reciprocating engine'.
1B Piston engine configurations
• Basic layout of in-line, vee and opposed engines.
• Importance of numbering cylinders
• Manufacturer conventions for similar engines.
• Firing order in different engine configurations.
• Effect of the number of cylinders such as smoothness of running, loads imposed, work done to reach higher speeds.
• Methods of ignition (spark and compression).

What needs to be learned
1C Requirements for an aircraft piston engine • Reliability. • Durability. • Maintainability. • Compactness. • High power/weight ratio. • High specific power output. • Fuel economy. • Low vibration. • Flexibility. • Cost.
Learning outcome 2: Understand the construction of aircraft piston engines
2A Construction, assembly and function of the crank case and its contents • Crank case construction, assembly and function, including its contents: o crank shaft o cam shafts o sumps o counterweights o vibration dampers o ball bearings (including thrust bearings, representative plain and roller bearings, oil seals). • Typical defects to be found in the above and their causes. • Typical defects to be found in the above and their causes. **2B Purpose, components and operation of accessory gearboxes** • Purpose of accessory gearboxes. • Component parts of a gearbox. • Lubrication system. • Operating principles. • Typical defects and causes associated with accessory gearboxes.

What needs to be learned

2C Construction, assembly and function of cylinders, pistons and connecting rod assemblies

- Construction, assembly and function of cylinders, pistons and connecting rod assemblies, including:
  - pistons
  - gudgeon pins (fixed and floating)
  - piston rings
  - cylinders
  - cylinder heads
  - connecting rods.
- Typical defects and their causes.
- Types of cylinder bore surface – rough, smooth:
  - reasons for each
  - precautions when working with each
  - types of piston ring for each
  - reasons for piston ring stagger.

2D Construction, assembly and function of inlet and exhaust manifolds

- Constructional features, function and materials of exhaust and inlet manifolds.
- Attachment, gaskets and seals.
- Typical defects and corrective action.

2E Construction, function and operation of valve mechanisms

- The construction, function and operation of valve mechanisms and components including:
  - cam followers
  - push rods
  - inlet and exhaust valves
  - sodium filled exhaust valves
  - seats
  - guides
  - springs
  - rocker assemblies
  - tappets (including hydraulic).

What needs to be learned

• Valve springs, fitting, number on each valve, prevention of binding.
• Typical defects including:
  o bowing of stems
  o pitting
  o glazing and chipping.
• Purpose of valve clearances.
• Effects of excessive valve clearance on valve timing and engine performance such as clatter, damage to valves and other components, loss of compression.
2F Purpose, mounting, lubrication and faults associated with propeller reduction gearboxes
• Purpose.
• Attachment to engine.
• Propeller attachment.
• Lubrication system.
• Typical faults and their causes.

Learning outcome 3: Understand the factors affecting piston engine power and efficiency

3A Power and efficiency
• Factors affecting engine power and efficiency including:
  o icing
  o altitude
  o temperature
  o ram air
  o barometric pressure
  o humidity
  o manifold pressure
  o brake specific fuel consumption (BSFC) and its calculation from given data.

What needs to be learned

3B Measuring thermal; and mechanical efficiency of a piston engine
• Simple calculations for the following efficiencies:
  o thermal - the ratio of work done to fuel used, expressed in heat or work units
  o mechanical - the ratio of power developed by expanding gas in the cylinders to the power delivered to the output shaft.
3C Volumetric efficiency of a piston engine
• Simple calculations for the volumetric efficiency of a piston engine - the volume of fuel/air charge (temperature and pressure corrected) compared with the total piston displacement of the engine (expressed as a percentage).

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 6: Principles of Gas Turbine Propulsion

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Have you ever wondered how aircrafts are able to fly such long distances and at such speed? The answer lies in the advanced propulsion technology used in aircraft gas turbine engine design.

In this unit, you will learn about the principles behind the operation of gas turbines used to power aircraft. Additionally, you will consider various engine designs and how the different sections of a gas turbine combine to allow power to be generated.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the design and operating cycle of a gas turbine engine	1.1 Describe aspects of the gas turbine cycle and Newton's laws of motion 1.2 Describe aspects of the main auxiliary systems of a gas turbine engine
2. Understand a variety of gas turbine configurations, their relative advantages and disadvantages as a propulsion system, and the selection of configurations for different aircraft applications	2.1 Describe aspects of one type of gas turbine configuration 2.2 Describe the relative advantages of one gas turbine configuration 2.3 Describe the selection of a gas turbine configuration for a type of aircraft application

Learning outcomes	Assessment criteria
3. Understand the benefits of gas turbine component designs and operating systems for key factors throughout the gas turbine's product lifecycle	3.1 Describe aspects of gas turbine component design variation 3.2 Describe one factor that affects gas turbine operation

Unit content

What needs to be learned
Learning outcome 1: Understand the design and operating cycle of a gas turbine engine
1A The gas turbine cycle and the laws of motion • The stages of the gas turbine cycle, referring to gas temperature, airflow, pressure and volume changes. • The main components and systems of a gas turbine including the variations in designs of each stage including: o intake o compressor o combustor o turbine o exhaust. • The application of Newton's law of motion to gas turbine engines relating to exhaust velocities and large and small mass flow rate. **1B The main auxiliary systems of a gas turbine engine and their contribution to key operational functions** • Main auxiliary systems of a gas turbine engine: o fuel o lubrication o cooling o electrical o hydraulic power. • The contribution made by the auxiliary systems to the operation, safety and reliability of the engine.
Learning outcome 2: Understand a variety of gas turbine configurations, their relative advantages and disadvantages as a propulsion system, and the selection of configurations for different aircraft applications
2A The different types of gas turbine configurations and their operation • The range of gas turbine configurations: o basic jet o turbojet including high and low bypass o turboprop

What needs to be learned

- geared fan
- turboshaft
- ducted fan.

- The fuel, weight, drag, thrust, speed, reliability, specialist capabilities of each configuration.
- The specific designs and operating conditions of each configuration.
- How thrust is achieved at a range of aircraft speeds, fuel consumptions and engine sizes by varying the physical parameters of the engine design.

2B The relative advantages and disadvantages of different gas turbine configurations as propulsion systems

- Turbojet:
  - advantages: relatively simple design, capable of very high speeds, take up little space
  - disadvantages: high fuel consumption, loud, poor performance at slow speeds, limited range and endurance.
- Turboprop:
  - advantages: very fuel efficient, most efficient at mid-range speed (250–400 knots), most efficient at mid-range altitudes (18,000–30,000 feet)
  - disadvantages: limited forward airspeed, gearing systems are heavy and can break.
- Turbo fan:
  - advantages: fuel efficient, quieter than turbojets
  - disadvantages: heavier than turbojets, larger frontal area than turbojets, inefficient at high altitudes.
- Turboshaft:
  - advantages: much higher power:weight ratio than reciprocating engines, smaller than reciprocating engines
  - disadvantages: loud, gear systems connected to the shaft can be complex and can break down.

2C The selection of gas turbine configurations for different types of aircraft applications

- Reasons for the selection of configurations for different aircraft applications such as the use of free-power turbines, twin spool compressors, combination of axial flow and centrifugal compressors.

What needs to be learned
• Compromises accommodated in the selection of configurations for contrasting airframe types.
Learning outcome 3: Understand the benefits of gas turbine component designs and operating systems for key factors throughout the gas turbine's product lifecycle
3A The different types of gas turbine component designs and variations • The design variations of the gas turbine components including: o fan o compressor blade o guide vanes o fuel nozzles o combustors o turbine blades o exhaust nozzles. **3B The factors affecting gas turbine operation** • Pressure ratios. • Spool speed matching. • Weight. • Mean time between failures (MTBF)/life on wing. • Combustion efficiency. • Turbine gas temperature. • Turbine component temperature. • Noise emissions.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 7: Space Propulsion Systems

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

No matter what method of propulsion is used to propel aircraft through the air, they all rely on the principle laid down in Newton's third law, which states in its simplest form that to every action there is an equal and opposite reaction.

In this unit, you will learn about the science of rocketry and specific methods of propulsion which launch rockets into space and outside the Earth's orbit. Finally, you will develop knowledge and understanding of the lifecycle of a rocket.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the methods of propulsion, propulsion systems and the science of rocketry	1.1 Describe a scientific concept behind rocketry 1.2 Describe aspects of a system in a spacecraft that controls propulsion 1.3 Describe aspects of how propulsion is created using a space propulsion method 1.4 Describe aspects of how propulsion is created in an electric propulsion system 1.5 Describe a method of propulsion that does not require a propellant
2. Understand how rocket systems get into space	2.1 Describe a key factor that influences propulsion 2.2 Describe aspects of how spacecraft communicate 2.3 Describe the function of a system within a rocket that controls navigation and guidance

Learning outcomes	Assessment criteria
3. Understand the concepts and science behind orbits	3.1 Describe an orbit and its relationship with gravity 3.2 Define one of Kepler's laws of planetary motion 3.3 Describe a classical orbital element (COE)
4. Understand the lifecycle of a rocket	4.1 Describe how to get into an orbit from Earth efficiently 4.2 Describe aspects of the importance of staging 4.3 Describe aspects of how a space propulsion system moves while in space 4.4 Describe aspects of a method by which objects are terminated or brought back down to Earth

Unit content

What needs to be learned
Learning outcome 1: Understand the methods of propulsion, propulsion systems and the science of rocketry
1A Scientific concepts behind rocketry • Newton's first, second and third laws of motion. • Conservation of momentum and inertia. • Relationship between impulse/specific impulse and thrust. • Purpose of the rocket equation. • Mass flow rate and its relationship to thrust. **1B Systems in a spacecraft that control propulsion** • Role of controllers (computers) in controlling propulsion. • Role of propellant management sensors in delivering the correct amount of fuel to a rocket engine. **1C How propulsion is created using different space propulsion methods** • Creation of thrust and its effect on propulsion in: o chemical systems o liquid-chemical systems o bipropellant systems o monopropellant systems o solar thermal systems o nuclear thermal systems. **1D How propulsion is created in various electric propulsion systems** • Creation of thrust and its effect on propulsion in: o electro-thermal systems o resistojet systems o electrostatic systems (ion thrusters) o electrodynamic systems (plasma thrusters). **1E Methods of propulsion that do not require a propellant** • Use of solar sails and their advantages and disadvantages in spacecraft propulsion • Use of space tethers and their advantages and disadvantages in spacecraft propulsion.

What needs to be learned

Learning outcome 2: Understand how rocket systems get into space

2A Key factors that influence propulsion

- Definition of thrust:weight ratio and its effect on lift.
- Ability of a rocket to manipulate the direction of thrust via throttling and thrust vector control.
- The relationship between dynamic pressure, region of max Q and G-loading when designing rocket systems.

2B How spacecraft communicate

- Communication architecture of spacecraft including primary satellites, relay satellites, ground stations and the control centre.
- Processes in which messages are sent to and from spacecraft, rockets, satellites and ground control including uplink, downlink and crosslink.
- Factors affecting signal:voice ratio, data rate and signal strength.

2C Systems within a rocket to control navigation and guidance

- Function of accelerometers in controlling navigation and guidance of rockets.
- Function of velocity vectors and their role in determining the required change in velocity to change direction.
- Functions of internal navigation systems (INS), navigation controllers and actuators.

Learning outcome 3: Understand the concepts and science behind orbits

3A Orbits and their relationship with gravity

- Typical orbit types including, parabolic, hyperbolic and elliptical.
- Newton's law of gravity, gravitational potential and its relationship to orbits.

3B Kepler's laws of planetary motion

- Definition of Kepler's first, second and third laws of planetary motion.
- Relevance of Kepler's three laws for travel within the solar system.

3C Classical orbital elements (COE)

- Overview of the following classical orbital elements: semi-major axis, eccentricity, inclination and true anomaly.

What needs to be learned
Learning outcome 4: Understand the lifecycle of a rocket
4A How to get into an orbit from Earth efficiently • Use of launch windows to rendezvous efficiently with objects in space. • Utilisation of the Earth's rotation and the launch location to assist with rocket launches. **4B The importance of staging and its unwanted effects** • Purpose and advantages of multi-stage rockets during a mission to space. • Disadvantages/unwanted effects of staging including reliability, complexity, build costs. **4C How space propulsion systems move while in space** • Initial concept of an orbital manoeuvre around Earth and a deep space manoeuvre around other celestial bodies. • Factor of delta v (Δv) in orbital transfers. • The Hohmann transfer and the transfer of orbits within the same orbital plane. **4D Methods by which objects are terminated or brought back down to Earth** • Use of propulsion systems in de-orbiting a spacecraft. • Use of propulsion systems in transferring to a graveyard orbit. • Angle of re-entry into the atmosphere and the maintaining of that angle using propulsion systems. • Re-entry window and the process of re-entry and the balance of deceleration, heating and accuracy of landing or impact.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 8: Aircraft Electrical and Avionics Systems

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Over the past two decades aircraft have become more and more reliant on electrical computer-based systems. Flight, engine management, environmental, safety and fire protection systems are all now utilising electronics and computer technology where they previously relied on mechanical inputs and control.

All aircraft systems are now fully integrated with various aircraft computing systems and these computers allow the aircrew access to far greater levels of control and information than they have ever experienced before. A thorough understanding of aircraft electrical and avionics systems and their underpinning principles is needed by aircraft technicians involved in the installation and maintenance of these systems.

In this unit, you will be introduced to a range of typical electrical and avionics systems installed on modern aircraft. These systems include a variety of airframe and propulsion applications, such as centralised warning systems, flight data recording and fire detection and overheating warning systems. You will also consider how the avionic systems installed on modern aircraft have developed significantly over the last few decades in terms of complexity and their level of integration with other aircraft systems.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Know the function of aircraft electrical and electronic systems	1.1 Describe aspects of the function of one type of aircraft/flight data recording system 1.2 Describe aspects of the function of one type of engine health monitoring system

Learning outcomes	Assessment criteria
	1.3 Describe aspects of the function of one type of airframe warning system 1.4 Describe aspects of the function of one type of safety/actuation system
2. Know the function of airframe electrical systems	2.1 Describe aspects of the function of one type of air data instrument 2.2 Describe aspects of the function of an aircraft pitot-static system 2.3 Describe aspects of the function of an air data computer (ADC)
3. Know the function of an automatic flight control system	3.1 Describe aspects of component interconnections in an automatic flying control system (AFCS) 3.2 Describe the basic function of one key AFCS component 3.3 Describe one AFCS mode of operation
4. Know the function of a flight management system (FMS)	4.1 Describe aspects of the area navigation function of a flight management system (FMS) 4.2 Describe aspects of the performance management function of an FMS

Unit content

What needs to be learned

Learning outcome 1: Know the function of aircraft electrical and electronic systems

1A Aircraft data recording systems

- The function of aircraft data recording systems:
  - to receive, route and record the recent flight history and the recent history of sounds in the cockpit that can assist in the investigation of aviation accidents and incidents.
- The function and use of flight data recorders and data acquisition systems:
  - flight data recorders (FDR) – used to collect and record aircraft performance parameters from sensors onto a medium that is designed to survive an accident
  - data acquisition systems – receive discrete analogue and digital parameters from sensors and avionics systems and route them to the FDR.
- The mandatory parameters, optional parameters, interpretation of data for the purposes of scheduled inspections and maintenance.

1B Engine health monitoring systems

- The function of engine health monitoring systems such as checking temperature, vibration and pressure recording:
  - to acquire and process data from engine monitoring sensors that can be used to support maintenance management using condition monitoring techniques such as:
    - the interpretation of data for the purposes of scheduling inspections and maintenance activities
    - the interpretation of data for the purposes of fault rectification and system repair.

1C Airframe warning systems

- Function of an aircraft's centralised warning system:
  - to inform the pilot of advisory and critical messages concerning aircraft systems and components.
- Function of configuration warning such as undercarriage and lift augmentation devices:
  - to inform the pilot of the current state of aircraft systems such as landing gear position, up and locked, down and locked, travelling.
- Function of bleed air overheat detection system:
  - to detect an overheat situation in the bleed air system and inform the pilot.

What needs to be learned

1D Safety and actuation systems

- Function of an ice and rain protection system:
  - preventing ice from forming on critical components such as wing leading edges, horizontal and vertical stabiliser leading edges, engine cowl leading edges, propellers
  - methods of ice prevention such as heating surfaces with hot air or electrical heating elements, spraying of chemicals.
- Function of landing lights, anti-collision lights, navigation lights and emergency lighting systems:
  - landing lights – used to illuminate the runway during takeoff, landing and taxiing and to enhance visibility during the landing approach
  - navigation lights – provide information on the aircraft's position, heading and status
  - emergency lighting systems – provide emergency lighting in the event of an electrical power failure.
- Actuation and control of landing gear extension, retraction and emergency operation.
- Electrical actuation of flying controls.

Learning outcome 2: Know the function of airframe electrical systems

2A Air data instruments

- Function of an airspeed indicator.
- Function of a vertical speed indicator.
- Function of an altimeter.

2B Aircraft pitot-static systems

- Function of the pitot and combined pitot/static tubes.
- Function of static vents.
- Function of pitot and static system leak checks.

2C Air data computer (ADC)

- Overview of the components and their interconnections of a typical air data computer in the form of a block schematic diagram.
- Function of an ADC – to provide data to Mach/airspeed indicators and the primary altimeter.

What needs to be learned

- The use and function of the air data computer inputs and outputs such as total temperature, static and pitot pressure, true air temperature, auto-throttle, autopilot, cabin pressure computer.

Learning outcome 3: Know the function of an automatic flight control system

3A Schematic block diagram of a typical automatic flight control system (AFCS)

- A visual overview of the components in a typical AFCS and their interconnections in block diagram form.

3B Basic function of key AFCS system components

- Function of the mode control panel – pilot interface with the AFCS and allows the pilot to select desired modes of operation.
- Function of the AFCS – uses inputs from aircraft systems and sensors to calculate flight path and control corrections for the AFCS.
- Function of the pitch, roll and yaw servos – make inputs to the flight surfaces to control the attitude of the aircraft.
- Function of the flight director and attitude references – flight director provides visual guidance on the attitude director indicator to fly an aircraft manually or to enable the pilot to visually monitor autopilot response to guidance commands.
- Attitude references – provide the pilot with information regarding the orientation of the aircraft relative to the Earth's horizon.

3C AFCS modes of operation

- Function of the roll channel – to monitor and correct for short-term oscillations about the longitudinal axis.
- Function of the pitch channel – to monitor and correct for short-term oscillations about the lateral axis.
- Function of the yaw channel – to monitor and correct for short-term oscillations about the normal (vertical) axis.
- Function of heading hold – when engaged, automatically maintains the aircraft's current heading.
- Function of auto landing mode – fully automates the landing procedure of an aircraft and enables airliners to land in adverse weather conditions.

Learning outcome 4: Know the function of a flight management system (FMS)

4A Area navigation function of an FMS

- Function of the navigation database – provides information to pilots in flight to create and modify flight plans. Also contains data on ground-based navigation aids used by an aircraft to determine its position.

What needs to be learned

- Route planning function – enables pilots to plan a flight path and waypoints using pre-determined data and pilot-defined waypoints.
- Function of navigation system management – enables the FMS.

4B Performance management function of an FMS

- Function of performance management – uses the flight plan, aircraft systems data and data from the navigation database to calculate the aircraft's present position and determine the necessary flight control commands to fly an optimum flight profile.
- Flight planner and management function – enables the pilot to create, modify and delete flight plans.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 9: Satellite Operations and Communication

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Satellites are an essential component in terrestrial communication, global positioning, climatic and environmental condition monitoring, and surface observation. Satellites are also used to explore the planets and moons in our galaxy and beyond.

In this unit, you will consider the principles and equipment used in Earth-tied and exploratory satellites and associated data communication. You will also explore the main types of satellite in use, their planetary orbits, roles and their construction. You will also study the International Space Station (ISS) and other exploratory satellites including the Deep Space Network communication systems.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the principles of satellites in terrestrial orbit, the main types and roles of satellites	1.1 Describe aspects of how satellites achieve and maintain terrestrial orbit 1.2 Describe one use of a military or civilian satellite
2. Understand the purpose and key function of the elements that make up the International Space Station	2.1 Describe one purpose of the International Space Station 2.2 Describe aspects of the method used to transfer resources to and from the International Space Station 2.3 Describe the function of one ISS node 2.4 Describe one effect of 'zero gravity' on one type of experiment that can be carried out on the International Space Station

Learning outcomes	Assessment criteria
3. Understand the purpose of exploratory satellites and the purpose of each type of satellite spacecraft	3.1 Explain the purpose of one exploratory satellite spacecraft currently in use 3.2 Describe aspects of the flight characteristics of one type of satellite spacecraft
4. Understand how satellite spacecraft communicate with the Deep Space Network	4.1 Describe one function of the Deep Space Network 4.2 Describe aspects of the operation of the Deep Space Network

Unit content

What needs to be learned
Learning outcome 1: Understand the principles of satellite in terrestrial orbit, the main types and roles of satellites
1A Principles of how geo-synchronous and polar synchronous satellites achieve and maintain terrestrial orbit • The type of launch vehicles used to launch satellites into orbit. • The sequence of events undertaken during the launch, orbit injection, perigee, transfer and apogee phases of satellites achieving their selected orbit. • Conditions and requirements of satellites to maintain a terrestrial orbit. **1B Principal uses of military and civilian satellites** • Uses of military and civilian satellites such as astronomy, communication, navigation, reconnaissance, remote sensing, search and rescue, space exploration and weather stations. • The advantages and disadvantages of using satellites for the following uses: astronomy, communication, weather monitoring, space exploration.
Learning outcome 2: Understand the purpose and key function of the elements that make up the International Space Station
2A Purpose of the International Space Station (ISS) • The research and technology developments during its time in service. • The nature of the international partnership that operates and controls the ISS. **2B Method of travel from Earth to the ISS** • The use of the Soyuz spacecraft in the transfer and return of cosmonauts, astronauts, goods and equipment from the Earth's surface. • The Soyuz spacecraft phases of flight. • The use of the Soyuz as the ISS lifeboat. **2C Function of the ISS Nodes** • The use of the Node 1 (Unity) docking and berthing ports. • The use of the Node 2 (Harmony) berthing ports. • The purpose of the ISS environmental services and electrical power equipment located in Node 2. • The use of the Node 3 (Tranquillity) docking and berthing ports. • The purpose of the ISS environmental services equipment located in Node 3.

What needs to be learned
2D Experiments that can be carried out on the ISS • The types of experiments carried out on the ISS: biological, Earth and space science, human research, physical science, technology development. • The effect of zero gravity on the six types of experiments carried out on the ISS.
Learning outcome 3: Understand the purpose of exploratory satellites and the purpose of each type of satellite spacecraft
3A Purpose of exploratory satellite spacecraft • The Flyby, Orbiter, Atmospheric and Observatory spacecraft. • The history and use of the Mariner 4 spacecraft. • The history and use of the Magellan spacecraft. • The history and use of the Galileo Atmospheric Probe. • The history and use of the Hubble Space Telescope. **3B Flight characteristics of satellite spacecrafts** • The flight characteristics of a Flyby spacecraft. • The flight characteristics of an Orbiter spacecraft. • The flight characteristics of an Atmospheric spacecraft. • The flight characteristics of an Observatory spacecraft.
Learning outcome 4: Understand how satellite spacecraft communicate with the Deep Space Network
4A Purpose of the Deep Space Network • Worldwide network of spacecraft communication facilities. • The functions of the Deep Space Network: o spacecraft telemetry – processing, decoding and distribution of telemetry data received from a spacecraft o spacecraft command – control of the activities of spacecraft such as command and control of a spacecraft's robotic probes o tracking – two-way communication between Earth and a spacecraft to allow flight controllers to determine the position and velocity of a spacecraft o radio science – the use of radio signals to determine information about far-off places in the solar system such as probing the rings of Saturn, testing the theory of relativity, revealing the interior structure of planets and moons

What needs to be learned

- science – use of the Deep Space Network as an advanced scientific research instrument such as its use in radio astronomy and radar mapping of passing asteroids.

- The international nature of the Deep Space Network:
  - countries and organisations that operate Deep Space Networks including NASA, Soviet Deep Space Network, Chinese Deep Space Network, Indian Deep Space Network, Japanese Deep Space Network, ESTRACK.
- Consultative Committee for Space Data Systems – international standards for operation of Deep Space Networks.

4B Operation of the Deep Space Network

- The location of the terrestrial antenna arrays.
- The purpose of the antenna arrays.
- The antenna array communication with spacecraft.
- The signal received by the antenna arrays.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 10: Data Networks

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

With the continuing advancement of computers and other technologies, networking is a key and fundamental part of IT services. Networks are a key part of any organisation's IT systems and are critical to many organisations' ability to do business. An infrastructure technician is expected to have a good theoretical understanding of network architecture and be able to install, configure and troubleshoot internal networks and access to the internet.

In this unit, you will gain understanding of the construction of a data network such as LAN, WAN and the internet and how a network's layers, protocols and addressing are used to provide reliable network communications.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the parts of a data network	1.1 Define the term data network 1.2 Describe aspects of the components of a data network 1.3 Describe aspects of the network media of a data network
2. Understand LANs, WANs and the internet	2.1 Describe the purpose/function of a local area network (LAN) 2.2 Describe the purpose/function of a wide area network (WAN) 2.3 Define the internet

Learning outcomes	Assessment criteria
3. Understand network layers	3.1 Describe aspects of the OSI 7-layer model 3.2 Describe aspects of the TCP/IP model. 3.3 Describe one difference between the OSI and TCP/IP models
4. Understand network addressing	4.1 Describe aspects of port addressing 4.2 Describe aspects of IP addressing 4.3 Describe aspects of MAC addressing

Unit content

What needs to be learned
Learning outcome 1: Understand the parts of a data network
1A Data network • Definition: an electronic communications process that allows for the orderly transmission and reception of information. **1B Components of a data network** • Definition of end devices: devices that form the interface between the human network and the underlying communication network. • Typical end devices such as computers, laptops, file servers, web servers, mobile devices. • Definition of intermediary devices: devices that connect end devices to a network or to connect networks together. • Typical intermediary devices such as routers/modems, firewalls, wireless access points, switches. **1C Network media of a data network** • The 'physical layer' associated with Transmission Control Protocol (TCP)/Internet Protocol (IP). • Copper media and its function. • Fibre optic media and its function. • Wireless media and its function.
Learning outcome 2: Understand LANs, WANs and the internet
2A Local area networks (LANs) • Purpose – a telecommunications network that can connect devices within a limited area such as the home, office building, school or university campus. • Function of LANs including: o connectivity: connections are either wired (Ethernet) or wireless (Wi-Fi) o administration: set up by individuals or local IT department within schools or businesses. **2B Wide area networks (WANs)** • Purpose: a telecommunications network that can connect devices from multiple locations across the globe. • Function of WANs including:

What needs to be learned
○ interconnectivity – access can be via different links such as virtual private networks (VPN), wireless networks, mobile networks and the internet ○ administration – established by service providers which then lease access to consumers. **2C The internet** • Definition: a global computer network (WAN) providing a variety of information and communication facilities, consisting of interconnected networks using standardised communication protocols.
Learning outcome 3: Understand network layers
3A OSI 7-layer model • The functions of the OSI model. • The interactions between layers in the OSI model. • The benefits of using a layered model including design, effect of one layer on another, common language. **3B TCP/IP model (Transmission Control Protocol/Internet Protocol)** • The functions of the TCP/IP model. • The interactions between layers in the TCP/IP model. • The benefits of using a TCP/IP model such as industrial standardisation, flow, error and congestion controls. **3C Similarities and differences between the OSI model and the TCP/IP model** • The similarities and differences of OSI and TCP models such as the number of layers, the OSI model is theoretical whereas the TCP model is used to transmit data. • The Level 4 OSI and TCP/IP model transport layer including Transmission Control Protocols (TCP), User Datagram Protocols (UDP), three-way handshake.
Learning outcome 4: Understand network addressing
4A Port addressing • The purpose of layer 4 port addressing such as source port and destination port numbering, providing communication and data flow control. **4B IP addressing** • Types of IP address – static and dynamic. • The limitations of Layer 3 IPv4 compared with IPv6 such as limited number of addresses, complexity of configuring IP addresses, lack of security.

What needs to be learned

- The benefits of Layer 3 IPv6 compared with IPv4 such as better end-to-end connectivity than IPv4, faster routing, ease of network administration, improved security.
- The use of 'undecillion' in IPv6 addressing.

4C MAC addressing

- The function of MAC addressing.
- The Institute of Electrical and Electronics Engineers (IEEE) rules of MAC addressing.
- The function of Address Resolution Protocol (ARP).

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 11: Principles of Radio and Radar Technology

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Radio and radar systems are fundamental to the safe operation of aircraft. Aircraft need to be made safer while reducing their environmental impact and maintaining or improving operational efficiency. This leads engineers to find new ways of improving radio and radar systems, while decreasing power consumption and maintaining the aircraft's operational tempo.

In this unit, you will develop an understanding of the characteristics and operating principles of radio and radar systems, as well as their associated components when utilised in aircraft. You will consider the core principles of radio and radar transmission and reception, which include the principles of key system components such as antennas and wave guides. Finally, you will understand and develop knowledge of operating aircraft radars by looking at various types such as weather and search radar.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand radio characteristics and the principles and operation of aircraft radio transmitters and receivers	1.1 Describe aspects of the principles of radio wave propagation 1.2 Describe aspects of a method to improve signal transmission
2. Understand the principles, applications and operation of radio transmitters, receivers, antennas and feeders	2.1 Describe aspects of the function of transmitters 2.2 Describe an application of one type of transmitter 2.3 Describe aspects of the function of a radio receiver

Learning outcomes	Assessment criteria
	2.4 Describe the function of one radio receiver component 2.5 Describe aspects of the operation of radio/radar antennas 2.6 Describe aspects of the operation and characteristics of feeders
3. Understand the principles and operation of radar systems	3.1 Describe aspects of the operation of radar systems 3.2 Describe aspects of the performance of a key radar system

Unit content

What needs to be learned
Learning outcome 1: Understand radio characteristics and the principles and operation of aircraft radio transmitters and receivers
1A Principles of radio wave propagation • The electromagnetic spectrum characteristics and the transmission of radio waves. • The principles of the propagation of radio waves (ground waves, sky waves, space waves) at different frequencies (LF, MF, HF, VHF and UHF). • The principles of amplitude modulation: DSB and SSB. • The principles of frequency modulation (FM). • The principles of digital modulation. **1B Methods to improve signal transmission** • Applications of different modulation methods: o amplitude modulation (AM) DSB and SSB o single-sideband (SSB) o frequency modulation (FM) o digital modulation (frequency-shift keying (FSK)) o phase-shift keying (PSK) o differential phase-shift keying (DPSK).
Learning outcome 2: Understand the principles, applications and operation of radio transmitters, receivers, antennas and feeders
2A Function and applications of transmitters • Function of transmitters: o to accept information signals to be transmitted and converted into a radio frequency (RF) signal capable of being transmitted o to generate a carrier signal of the correct frequency o to provide modulation that causes the information signal to modify the carrier wave o to provide power amplification to ensure that the signal level is high enough to carry over the desired distance o to provide circuits to impedance match the amplifier to the antenna. • VHF applications: o digital audio broadcasting (DAB)

What needs to be learned

- FM radio broadcasting
- television broadcasting
- two-way mobile radio systems
- marine communications
- air traffic control
- air navigation systems such as VOR and ILS.

- UHF applications:
  - television broadcasting
  - mobile phone communications
  - Wi-Fi
  - Bluetooth
  - cordless phones
  - GPS.
- HF applications:
  - military and government communications systems
  - aviation air-to-ground communications
  - Global Maritime Distress and Safety System communication
  - over-the-horizon radar systems.
- The function of a typical aircraft transmitter and associated components.

2B Function and components of radio receivers

- Function of radio receivers – to accept transmitted signals and convert them back into a form understandable by humans.
- Function of typical radio receiver components.
- Oscillators – create an alternating current that forms the carrier wave signal.
- Demodulator – recovers the original information signal from the modulated carrier.
- Output device – speaker or LCD screen that reads out or displays the original information signal.

2C Operation of radio and radar antennas

- Function of antennas in transmission:
  - the radio transmitter supplies electrical current to the antenna
  - the antenna radiates the energy from the current as radio waves.

What needs to be learned

• Function of antennas in reception:
  o the antenna intercepts some of the power of a radio wave and produces an electrical current at its terminals and sends it to the receiver
  o the receiver receives the electrical signals, amplifies them and then coverts them back into the original form.
• The location of radio and radar antennas on a large aircraft and why the location is suitable for that type of antenna.
• Typical frequencies used in association with radio and radar antenna in terms of: beam; ground-plane; helical; parabolic reflector; phased array; rod; slot; loop; plate; horn and dielectric types.
2D Operation and characteristics of feeders
• The operation and characteristics of coaxial (flexible and rigid) and waveguide (rigid and flexible) feeders.
• The key differences between coaxial (flexible and rigid) and waveguide (rigid and flexible) feeders.
• Feeder electrical specifications in terms of characteristic impedance, loss, frequency response and power handling.

Learning outcome 3: Understand the principles and operation of radar systems
3A Operation of radar systems • Operation of typical primary, secondary, pulsed and continuous wave radar transmitters. • Application of typical primary and secondary, pulsed and continuous wave radar transmitters. • Primary and secondary aircraft radar systems for both weather and surveillance radar. **3B Performance of key radar systems and radar specifications** • Factors that can affect the performance of an aircraft radar system such as slant range, bearing, elevation angle, clutter, transmitter power. • Use and operation of a large aircraft's radar system.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 12: Space Travel

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Space travel is the key component in developing our understanding of our solar system and beyond. Nonetheless, it does present significant challenges due to the time it takes to travel the vast distances involved and the nature of space's hostile environment.

In this unit, you will gain an overview of the basic principles and challenges faced by manned and unmanned spacecraft attempting space flight. You will explore the construction of a spacecraft, the requirements to maintain human life, how Earth-to-spacecraft communication is achieved and how planetary gravitational forces can be utilised to assist space travel.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the factors that need to be considered in spacecraft design	1.1 Describe aspects of one construction material used in spacecraft design 1.2 Describe aspects of how one type of electrical supply for a spacecraft is generated 1.3 Describe one hazard of space flight for a spacecraft
2. Understand the different factors and practicalities involved with space flight	2.1 Describe one requirement of space suit design in order to support human life 2.2 Describe aspects of how spacecraft long-range communication is achieved

Learning outcomes	Assessment criteria
3. Understand how spacecraft escape the Earth and other planetary bodies	3.1 Describe aspects of the gravitational effect of the Earth/other planetary bodies 3.2 Describe aspects of achieving minimum escape velocity when leaving the atmosphere of a planet 3.3 Describe aspects of how gravity assist/gravitational slingshot is used to propel spacecraft into space

Unit content

What needs to be learned
Learning outcome 1: Understand the factors that need to be considered in spacecraft design
1A Construction materials used in spacecraft design • The use and properties of various metallic materials in different areas throughout the spacecraft such as aluminium-lithium alloys, titanium alloys, Inconel, copper, nickel. • The use and properties of various non-metallic materials in different areas throughout the spacecraft such as silicone rubber (RTV580), aramid fibres, Kapton polyimide, carbon fibre reinforced epoxy resin (CFRP). **1B Spacecraft electrical supply generation** • The use of fuel cells to generate spacecraft electrical supplies. • The use of solar panels to generate spacecraft electrical supplies. • The storage of electrical energy used in space flight. **1C Hazards to spacecraft during space flight** • The extreme temperature variation experienced during space flight. • How micro meteorites, meteorites and other types of space debris present a hazard to spacecraft in flight.
Learning outcome 2: Understand the different factors and practicalities involved with space flight
2A Requirements of space suit design to support human life • The requirement for: o suit pressurisation o environmental control and a continuous air supply o protection against space radiation o articulation and ease of movement o communication. **2B Spacecraft long-range communication** • The use of the Deep Space Network to communicate with spacecraft. • The type of radio communication used for deep space communication.

What needs to be learned
Learning outcome 3: Understand how spacecraft escape the Earth and other planetary bodies
3A Gravitational effect of the Earth and other planetary bodies • The nature of the Earth's gravity and its influence on a mass. • The nature of different gravity fields emanating from other planetary bodies. **3B The importance of achieving minimum escape velocity when leaving the atmosphere of the Earth or a planetary body** • The relationships between velocity, gravitational constant, mass of the body to be escaped from and distance between the centre of mass of the body and the escaping object. • The relationship between fuel use, fuel loading and weight. • How changes in spacecraft propulsion systems and spacecraft design have led to small and lighter spacecraft. **3B Tow gravity assist and gravitational slingshot are used to propel spacecraft into space** • The use of planetary motion to impart positive and negative accelerations on a spacecraft. • Gravity assist: changing a spacecraft's velocity (relative to the Sun) by entering and leaving the gravitational sphere of influence of a planet. • Gravitational slingshot: a manoeuvre that can be used to change the spacecraft's trajectory and speed relative to the Sun. • The use of the spacecraft's momentum to assist in achieving interstellar space travel. • The advantages and disadvantages of gravity assist in the generation of positive and negative accelerations.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 13: Cyber Security and IT

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Computer security is an important issue for the economy and for government organisations. For example, engineering organisations undertake cutting-edge research and need to invest in sophisticated systems to protect information and intellectual property with passwords, security passes and sophisticated physical locks. Government organisations handle information that is highly sought after by foreign countries – for example, they possess highly classified state and military secrets such as the details of how military equipment works. In addition, within a battlespace, adversaries seek intelligence in a bid to outfox the opposing side and gain an upper hand in a conflict. As a result, all personnel must have an understanding of security issues.

In this unit, you will investigate a range of computer security threats, computer system vulnerabilities and security-protection measures that are used in industry and governmental organisations. You will also investigate the legal requirements placed on organisations to protect information and systems.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Investigate the threats to computer systems in organisations and the organisations' legal responsibilities	1.1 Describe characteristics of computer system security threats 1.2 Describe aspects of the legal responsibilities that an organisation has for the security of their computer systems
2. Investigate computer system vulnerabilities and protection measures used in organisations	2.1 Identify one type of vulnerability that exists in computer systems 2.2 Identify one type of physical security measure

Learning outcomes	Assessment criteria
	2.3 Describe aspects of software/hardware security measures 2.4 Describe aspects of policy-based security measures
3. Investigate the requirements of governmental and military information security	3.1 Describe aspects of the importance of data security in a military battlespace 3.2 Describe aspects of military IT security

Unit content

What needs to be learned

Learning outcome 1: Investigate the threats to computer systems in organisations and the organisations' legal responsibilities

1A Computer system security threats

- All computer systems are vulnerable to attack from external and internal threats.
- Internal threats include:
  - employee sabotage and theft, e.g. of physical equipment or data, and damage, such as fire, flood, power loss, terrorism or other disaster
  - unauthorised access by employees and other users to secure areas and administration functions, including security levels and protocols
  - weak security measures and unsafe practices, e.g. security of computer equipment and storage devices, security vetting of visitors, visiting untrusted websites
  - accidental loss or disclosure of data, e.g. poor staff training and monitoring.
- External threats include:
  - malicious software (malware) and how it functions, including viruses, worms, spyware, adware, rootkits and Trojan horses
  - hacking, e.g. commercial, of government or individuals
  - sabotage, e.g. commercial, government, terrorism, individuals
  - social-engineering techniques used to obtain secure information by deception.
- The impact of a successful breach an organisation including:
  - operational loss, e.g. manufacturing output
  - financial loss, e.g. organisational, compensation and liability
  - reputation loss, e.g. lack of service and employee or customer information
  - intellectual property loss, e.g. new product design.

1B Legal responsibilities

- UK legislation or other relevant international equivalents, including:
  - data protection legislation and amendments, requirements for organisations to keep data secure
  - Official Secrets Act 1989
  - computer misuse legislation and amendments, definitions of illegal practices and applications

What needs to be learned

- telecommunications (Lawful Business Practice) (Interception of Communications) regulations and amendments, requirements to allow companies to monitor an employee's communication and internet use while at work
- fraud legislation and amendments, requirements to deal with services using IT-based methods to steal information for fraudulent purposes.

Learning outcome 2: Investigate computer system vulnerabilities and protection measures used in organisations

2A Computer system vulnerabilities

- Understand that different types of computer system are exposed to different threats and contain different vulnerabilities. Possible vulnerabilities include:
  - network, e.g. open firewall ports
  - organisational, e.g. inappropriate file permissions or privileges, password policy
  - software, e.g. from an untrusted source, torrent-downloaded software, illegal copies
  - operating system, e.g. unsupported versions, updates not installed
  - physical, e.g. theft of equipment, USB storage devices with sensitive data, collection of passwords and other information by social-engineering methods
  - process of how people use the system, e.g. leaks and sharing security details.

2B Physical security measures

- Physical security measures and their effectiveness including:
  - site security, e.g. locks, card entry, biometrics, closed circuit television (CCTV)
  - data storage, data protection and backup procedures, including planned automated backup, on- and off-site data storage, cloud storage.

2C Software/hardware security measures

- Software/hardware security measures and their effectiveness including:
  - anti-virus software and detection techniques, such as virus signatures, heuristics techniques used to identify potentially suspicious file content, techniques for dealing with identified threats
  - software/hardware firewalls and the filtering techniques they use, such as packet filtering and inspection, application layer awareness, inbound and outbound rules, network address

What needs to be learned

- user authentication, such as user logon procedures, strong password, text and graphical password, biometric authentication, two-step verification, security tokens, e.g. USB-based keys, knowledge-based authentication, e.g. question and response pairs, Kerberos network authentication for Windows and Linux-based operating systems, certificate-based authentication
- access controls and the methods to restrict authorised/unauthorised users' access to resources, e.g. user groups and the access rights allocated to resources, such as folders, files and physical resources such as printers, and Linux octal file permissions
- the principles of encryption such as shift ciphers, one-time pads, hashing, symmetric and public key encryption, file/folder encryption, disk encryption products
- precautions that can be taken to protect a wireless local area network (LAN) from unauthorised access, e.g. MAC address filtering and hiding the service set identifier (SSID), wireless encryption such as Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA) and Wi-Fi Protected Setup (WPS), mitigating known wireless vulnerabilities
- consideration of security issues during network and system design to ensure security is built in from the development stage.

2D Policy-based security measures

- Policy-based security measures and their effectiveness including:
  - organisation policies and their application, including policies on internet and email use, security and password procedures, staff responsibilities, staff IT security training
  - security audits and their application to check compliance against policies
  - backup of data.

Learning outcome 3: Investigate the requirements of governmental and military information security

3A The importance of data security in a military battlespace

- History of information warfare, government code and cypher school, enigma code, use of information obtained to determine battle plans and strategy.
- How modern threats such as extremist organisations, state-sponsored groups, foreign governments can gain an advantage by compromising national/battlespace security.

What needs to be learned

3B Military IT security

- Security classifications and storage media colour coding:
  - official – the majority of information that is created or processed by the public sector. This information is stored in buff-coloured files/folders
  - official sensitive – routine business operations and services which may have damaging consequences if lost, stolen or disclosed. This information is stored in buff-coloured files/folders
  - secret – very sensitive information that justifies heightened protective measures such as where disclosure could seriously damage military capabilities or international relations. This information is stored in pink-coloured files/folders
  - top secret – the most sensitive information that requires the highest levels of protection such as where disclosure could cause widespread loss of life or threaten the security or economic wellbeing of the country. This information is stored in red-coloured files/folders.
- Transferring of official information from one computer to another – only transfer to a computer of the same security classification or higher.
- Individuals' responsibilities around operation security (OPSEC) and social media such as not sharing exact location of forces personnel overseas, not sharing information on troop movements, not posting the metadata when uploading photos/status updates online.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 14: Aviation Meteorology

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

The Earth's atmosphere is constantly changing and varies greatly all over the world. It is a system that is not only essential to life on Earth but is supported by the life it serves. The ever-changing properties of the atmosphere, such as temperature, air pressure and air density, are key elements in creating the weather we experience.

In this unit, you will develop your knowledge of the layers and properties of the atmosphere and their relationship to changing weather patterns. You will study humidity and air density as air density has a major influence on the four forces of flight. Finally, you will explore different weather phenomena that can and do affect flight safety.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the structure of the Earth's atmosphere	1.1 Describe one characteristic of the Earth's atmosphere 1.2 Describe aspects of the components of the atmosphere 1.3 Describe aspects of the International Standard Atmosphere (ISA)
2. Understand how air density is affected by variances in air temperature and pressure within the atmosphere	2.1 Describe one factor that causes air temperature changes within the troposphere/stratosphere 2.2 Describe one factor that causes pressure changes within the troposphere and stratosphere 2.3 Describe aspects of how atmospheric air temperature and air pressure affect air density

Learning outcomes	Assessment criteria
3. Understand how humidity affects air density	3.1 Define aspects of relative humidity 3.2 Describe how changing humidity affects air density
4. Understand how the weather is influenced by different air masses and associated weather conditions	4.1 Describe one air mass that affects the weather in Great Britain 4.2 Describe one hazard to aviation from the Föehn effect 4.3 Explain how one type of cloud and its associated weather pattern form 4.4 Describe aspects of atmospheric visibility 4.5 State one type of fog 4.6 Describe how one type of fog forms 4.7 Describe how one type of fog disperses

Unit content

What needs to be learned
Learning outcome 1: Understand the structure of the Earth's atmosphere
1A Characteristics of the Earth's atmosphere • The characteristics of the troposphere, stratosphere, mesosphere, thermosphere and exosphere in terms of aviation and human interaction. • The location of the ozone layer, its importance and fragility. **1B Components of the atmosphere** • The components of pure air, nitrogen, oxygen, carbon dioxide and the noble gases. • The changes to components of air with changes in altitude. • The effect on human beings of changes in altitude. **1C The International Standard Atmosphere (ISA)** • The use of a standard set of atmospheric values to assist engineers, pilots and navigators. • International Standard Atmosphere values for the temperature, temperature lapse rate, air pressure and air density.
Learning outcome 2: Understand how variances in air temperature and air pressure effect air density within the atmosphere
2A Factors affecting troposphere/stratosphere air temperature changes • The use of temperature to measure molecular energy. • The propagation of solar radiation and heat energy through the atmosphere. • The effects of varying global latitudes and the day/night cycle on the temperature. • The local effect on temperature due to changing topography. **2B Factors affecting troposphere/stratosphere air pressure changes** • The scientific principle of pressure created by a gas. • The effect of gravity on the atmospheric air pressure from sea level through to the upper limit of the stratosphere. • The types of pressure experienced by aviation in the atmosphere, static and dynamic pressures. • The effects of varying global latitudes on the air pressure. **2C Changes in atmospheric air temperature and air pressure on air density** • The scientific principle of air density.

What needs to be learned

- The ideal gas law and the relationship between temperature, pressure and density of a gas.
- The atmospheric interaction of air temperature and air pressure on the air density.

Learning outcome 3: Understand how humidity affects air density

3A Relative humidity

- The scientific principle of relative humidity.
- The influence of water vapour contained within the atmosphere.
- Definition of relative humidity – the amount of water vapour present in air expressed as a percentage of the amount needed for saturation at the same temperature.
- Definition of saturation – the extent to which water is absorbed by air expressed as a percentage of the maximum possible.
- Definition of dew point – the atmospheric temperature below which water droplets begin to condense and dew can form.

3B Humidity's effect on air density

- The decrease in air density with increasing humidity.
- The changes to atmospheric humidity due to the different geographical locations.
- The changes in air temperature due to changes in atmospheric humidity levels.

Learning outcome 4: Understand how the weather is influenced by different air masses and associated weather conditions

4A Different air masses affecting the UK

- The characteristics associated with an air mass.
- The weather characteristics of the six air masses associated with Great Britain:
    - Polar Maritime Air Mass – wet, cold air bringing cold showery weather
    - Arctic Maritime Air Mass – wet, cold air bringing snow in winter
    - Polar Continental Air Mass – hot air brings dry summers, cold air brings snow in winter
    - Tropical Continental Air Mass – hot, dry air brings hot weather in summer
    - Tropical Maritime Air Mass – warm, moist air brings cloud, rain and mild weather
    - Returning Polar Maritime – moist, mild and unstable air brings cloud and rain showers.

What needs to be learned

4B Air movement due to terrain

- Föehn effect:
  - the development of mountain waves
  - how waves can be identified
  - what hazards exist to aviation around mountain waves.

4C Different cloud types and their associated weather patterns

- Stratiform and cumuliform clouds.
- How turbulence, convection, topography and fronts each produce clouds.
- Cumulus clouds can develop into thunderstorms; the hazards to pilots associated with thunderstorms.
- How cloud type, vertical thickness and temperature produce different types of precipitation.

4D Atmospheric visibility

- UK flight rules with regards to atmospheric visibility:
  - the minimum visibility at speeds greater than 250 kt should be 8 km with a horizontal clearance from cloud of 1500 m
  - minimum visibility at 140 kts or less during the day is 1500 m for airplanes and helicopters
  - minimum visibility at 140 kts or less at night for helicopters is 3 km
  - the haze layer effects on flight safety.
- Definition of haze layer: the altitude at which water droplets condense into water vapour, causing haze.
- Effects on flight safety – reduced visibility below the haze layer, significant improvement in visibility above the haze layer.
- Definition of atmospheric visibility: a measure of the distance at which an object or light can be clearly discerned.

4E Different types of fog

- The different types of fog that can form due to changing atmospheric conditions:
  - radiation fog
  - valley fog
  - advection fog
  - upslope fog
  - evaporation fog.

What needs to be learned

4F The atmospheric conditions required for different types of fog to form

- Radiation fog – occurs in the winter, aided by clear skies and calm conditions. The cooling of land overnight by thermal radiation cools the air close to the surface. This reduces the air's ability to hold moisture, allowing condensation and fog to occur.
- Valley fog – forms where cold dense air settles into the lower parts of a valley, condensing and forming fog. It is often the result of a temperature inversion, with warmer air passing above the valley.
- Advection fog – occurs when moist, warm air passes over a colder surface and is cooled.
- Upslope fog – occurs when wind blows air up a slope, causing the air to cool as it rises.
- Evaporation fog – caused by cold air passing over warmer water or moist land. It often causes freezing fog, or sometimes frost.

4G The atmospheric conditions required for commonly found fogs to disperse

- Radiation fog – usually dissipates soon after sunrise as the ground warms. An exception to this can be in high elevation areas where the Sun has little influence in heating the surface.
- Valley fog is confined by local topography and can last for several days in calm conditions during the winter.
- Advection fog usually dissipates when the surface is heated.
- Upslope fog dissipates when the air is heated or when the wind blows down a slope.
- Evaporation fog dissipates when the sun heats the surface.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 15: Aviation Operations

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

'Aviation operations' is a broad term for activities within a varied and challenging environment. It encompasses many different job roles such as ramp agent, dispatcher, baggage loader as well as air cargo, airport operations and airside safety – all have a clear role to play in achieving safe, secure and on-time aircraft departures.

This unit covers airfield operations in terms of legislation and airport operations. The unit gives you the opportunity to explore the framework in which aviation organisations operate. You will consider the role of the various organisations involved in terms of meeting the standards of aircraft and airfield performance, which are vital for the safety of the aircraft, passengers, ground crew and flight crew during ground operations, from landing to take-off.

You will also investigate staff training and development programmes, identifying how systems are used to monitor and improve skill levels. There will be an introduction to the requirements for tactical planning and monitoring of airfield activities and functions. Finally, you will gain an understanding of how airfield facilities are inspected on a daily basis along with the associated reporting regimes.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand how to meet the training requirements of personnel operating within the airfield environment	1.1 Describe aspects of one aviation training and development programme 1.2 Describe aspects of a system used to monitor aviation staff performance 1.3 Define a mandatory requirement to be able to drive a vehicle within an airfield environment

Learning outcomes	Assessment criteria
2. Know the monitoring and planning requirements of airport activities	2.1 Describe aspects of one monitoring/planning requirement for aircraft arrivals and departures 2.2 Describe aspects of one monitoring requirement for aircraft parking 2.3 Describe aspects of one requirement to control the manoeuvring of vehicles within the airfield environment
3. Understand procedures for inspecting airfield facilities	3.1 Describe aspects of one procedure for the inspection of a runway surface 3.2 Describe aspects of one procedure for inspecting airfield lighting 3.3 Describe aspects of one procedure for monitoring foreign object debris (FOD) within the airfield 3.4 Describe aspects of observing/documenting/reporting birds and other wildlife 3.5 Describe one reason why deficiencies found during inspections must be reported

Unit content

What needs to be learned

Learning outcome 1: Understand how to meet the training requirements of personnel operating within the airfield environment

1A Training and development programmes

- Initial training programmes, e.g. corporate structure, uniform standards, company procedures.
- Mandatory training, e.g. fire, General Security Awareness Training (GSAT), National Aviation Security Programme (NASP), manual handling.
- Airside safety management, e.g. geography of stands, rules of parking, positioning and stowing of equipment, identifying and understanding markings and lines on stands.
- Air bridge driving.
- Procedures for approaching aircraft, e.g. anti-collision lights, engines off.
- Coordinating airfield training and development (regulatory requirements): Airside Safety Management (CAP 642), the Air Navigation Order 2005 (CAP 393), airside safety committee, airside work permit; airside safety performance and management.

1B Systems in place for training and monitoring of staff

- Annual staff training, e.g. manual handling, air bridge/jetty licence, dispatch, load planning and load control, fire training, Accounting and Authorisation of Hold Baggage for Carriage by Air (AAA), dangerous goods.
- Monitoring staff performance, e.g. annual competence checks, auditing of ground staff, safety and procedures (IATA Airport Handling Manual – AHM560), Department for Transport (DfT) checks, Health and Safety Executive (HSE) spot checks, monitoring of on-time aircraft departures, shadowing, target setting, mentoring.

1C Training requirements for airside driving

- Qualifications, e.g. full UK driving licence, MOD driving permit, Airport Operators Association (AOA), local familiarisation, speed limits, airside driving permit, specialist vehicle licence, approaching aircraft, movement of vehicles on the manoeuvring area.
- Medical requirements, e.g. vision and hearing tests.
- Vehicle standards awareness, e.g. MOT standard, hazard beacon, free from FOD, carrying company logo, airside permit.

What needs to be learned

Learning outcome 2: Know the monitoring and planning requirements of airport activities

2A Monitoring and planning requirements of aircraft arrivals and departures

- Monitoring and planning requirements, e.g. slot allocations, IATA scheduling procedure guide, regular schedule services, programmed charter services, irregular services (ad hoc, etc), general aviation, military operations, grandfather rights.
- Achieving slot times.
- Aircraft parking and ramp design, e.g. simple terminal, piers, air bridges, satellites, multiple terminals with access links.
- Delays and cancellations.

2B Monitoring requirements of aircraft parking

- Function of automatic parking guides, e.g. Burroughs Optical Lens Docking System (BOLDS), Azimuth Guidance for Nose-in Stands (AGNIS), side marker boards (SMB), Parallax Aircraft Parking Aids (PAPA), Aircraft Parking and Information System (APIS).
- Stand readiness, e.g. clear of aircraft, vehicles, personnel, FOD, airbridge retracted, adequate size for planned aircraft.

2C Manoeuvring operations within the airfield

- Aircraft movement:
  - marshalling signals and procedures
  - speed of aircraft manoeuvre
  - radius of aircraft turn
  - tug
  - pushback
  - powerback
  - centreline guidance
  - stopping guidance.
- Requirements to control the movement of vehicles airside:
  - Airside Vehicle Permits (AVPs)
  - Department for Transport test certificate
  - control of vehicle movements
  - regulations in place for taxiway crossing
  - obstruction of lights

What needs to be learned

- manoeuvring areas
- driving permit rules – vehicles must not be driven across aircraft stands unless directly involved in the turnaround operation of the aircraft using or about to use the stand
- enforcement – Airside Safety Unit (ASU), penalties, withdrawal of driving permit, Civil Aviation Authority regulations and legislation (CAP642, CAP790), military regulations and legislation.

Learning outcome 3: Understand procedures for inspecting airfield facilities

3A Runway surface inspection procedures

- Inspection regime, e.g. routine (daily/twice-daily complete surface check), detailed (detailed inspection of limited area), management inspection, special (following up a report of a suspected problem).
- Focus of inspection, e.g. surface (cracking, displaced, flooding, snow/ice covered, FOD), edges (crumbling, drains blocked, damaged facilities), markings (centre line, touch-down markers, lead-off lines), work in progress (infringing runway safety areas), wildlife (especially birds).

3B Airfield lighting inspecting procedures

- Inspection regime, e.g. routine (prior to sunset, daily), special (following up a reported fault); focus of inspection, e.g. approach lighting systems, approach slope indicators, airfield beacon, runway centre line lights, runway edge lights, CAT3 stop lights, wig-wags, Visual Approach Slope Indicator (VASI), Precision Approach Path Indicator (PAPI).
- Checks, e.g. functionality, brightness, clean lenses.

3C Procedures for monitoring foreign object debris (FOD)

- Routine inspections.
- Prevention, e.g. FOD containers, training.
- Maintenance, e.g. sweeping, magnetic bars, rumble strips.
- Enforcement, e.g. identify source of FOD, ensure offenders clear up, fine repeat offenders.
- Typical FOD, e.g. pavement fragments, catering supplies, building materials, rocks, sand, pieces of luggage, wildlife and insects.

3D Observing, documenting and reporting birds

- Designated staff.
- Routine patrols.

What needs to be learned

- Knowledge of bird habits.
- Observe regular patterns of movement.
- Record significant sightings.
- Identify types of bird.
- Share information with ATC.
- Bird strikes reported to ATC and CAA (CAP772).
- Records used to guide local prevention and dispersal planning.

3E Importance of reporting deficiencies

- Airfield, e.g. liability (landlord, responsible for major facilities, damage/injury to third-party users – airlines/passengers), reputation, damage to business, aircraft safety, accident prevention, delays, costs.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 16: Unmanned Aircraft Systems

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

'With the continuing advancement in computers and other technologies, Unmanned Aircraft Systems (UAS) are playing a much more significant role in areas such as military operations, search and rescue, and geographical surveying.

In this unit, you will investigate the function and operation of UAS. You will explore the role of, operating systems, remote control, design features and requirements of military, civilian and private use UAS. You will apply understanding of the current regulations and social implications associated with the use of UAS in UK airspace.

This unit will help to prepare you for a career in aircraft engineering or the aviation industry. It can also help you to find work as an aircraft technician. Alternatively, you could choose to continue your studies in higher education.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand what is meant by an Unmanned Aircraft System	1.1 Define the type and class of one UAS 1.2 Describe one UK military application of a UAS 1.3 Describe aspects of UK civilian, commercial and private applications of UAS 1.4 Describe aspects of the benefits and limitations of UAS
2. Understand the common operations of the Unmanned Aircraft Systems	2.1 Describe aspects of the operating principles of UAS 2.2 Describe aspects of UAS flight control systems 2.3 Describe aspects of UAS remote control technology

Learning outcomes	Assessment criteria
3. Understand the design features and components of Unmanned Aircraft Systems	3.1 Describe aspects of the design features of a UAS 3.2 Describe the purpose of one component of a UAS 3.3 Describe aspects of the benefits and limitations of cameras/other imaging systems used in UAS technology
4. Understand the safety, regulatory and social restrictions of Unmanned Aircraft Systems	4.1 Identify one factor that allows UAS flying activities to be managed safely 4.2 Describe aspects of legal regulation for UAS flying activities

Unit content

What needs to be learned
Learning outcome 1: Understand what is meant by an Unmanned Aircraft System

1A Type and classes of Unmanned Aerial Systems
• The term Unmanned Aircraft Systems (UAS), e.g. types – Unmanned Aerial Vehicle (UAV), drone, Remotely Piloted Aircraft System (RPAS).
• Typical uses of military, civil and private UAS.
• The following classes of UAS:
  o Class I – nano, micro, mini, small
  o Class II – tactical
  o Class III – MALE, HALE, Strike.
1B Military UK applications of Unmanned Aircraft Systems (UAS)
• The UK military application of Unmanned Aircraft Systems to support ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance).
• The UAS attack role and armament systems.
1C UK civilian, commercial and private applications of Unmanned Aircraft Systems (UAS)
• Applications of civilian UAS in the following categories: search and rescue, monitoring weather patterns, conservation, environmental and policing.
• Application of commercial UAS in the following categories: geographical surveying, marketing, film and television production, site surveying, parcel and package deliveries, imaging structure, precision agriculture, lighting shows, inventory accounting, insurance and sports.
• Applications of private UAS in the following categories: recreational flying, low-cost aerial photography.
1D Benefits and limitations of Unmanned Aircraft Systems (UAS)
• Benefits of UAS: range of sizes, capabilities, cost-effectiveness, reliability, maintainability, operational availability, military and scientific system applications.
• Limitations of UAS: capacity in comparison to other aircraft systems, safety concerns, property, privacy (public and private), control of the UAS.

What needs to be learned

Learning outcome 2: Understand the common operations of the Unmanned Aircraft Systems

2A Operating principles of Unmanned Aircraft Systems

- Primary responsibility of an operator is to determine how the UAS is being flown and to avoid collision with other aircraft, objects or people.
- Visual Line of Sight (VLOS) of the remote pilot – the UAS must be clearly seen by the remote pilot at all times during flight; image-enhancing devices such as binoculars or telescopes to track and monitor the UAS are prohibited.
- Beyond the Visual Line of Sight (BVLOS) of the remote pilot – if a UAS is flown beyond visual line of sight, the following criteria must be met:
    - The UAS must have detect and avoid (DAA) capability to 'see and avoid' potential conflictions
    - The UAS must be flown in clear airspace that is restricted for other aircrafts.

2B Unmanned Aircraft Systems (UAS) flight control systems

- The operation UAS flight control systems for military, commercial and private equipment such as the operation of the attitude and heading reference system in gathering roll, pitch and yaw data so the flight control computer can autonomously navigate and control the UAS.
- The UAS flight control key components for military, commercial and private equipment including:
    - ground control station components such as datalinks, flight control joysticks, display screens for onboard cameras/sensors
    - onboard components such as flight control computers, servos, communications links, cameras, sensors, air data systems, attitude and heading reference systems, power plant, electrical supplies.

2C UAS remote control technology

- The principles and operation of UAS remote control using radio transmitters, global positioning system, Wi-Fi and Bluetooth.
- The difference between 'static' and 'mobile' control technology.

Learning outcome 3: Understand the design features and components of Unmanned Aircraft Systems

3A Design features of Unmanned Aircraft Systems (UAS)

- The structural design features of Unmanned Aircraft Systems (UAS) to meet the following design requirements: speed, payload variation, time on station, weapon systems.

What needs to be learned
• The infrastructural design features of UAS including ground control station, communications and command datalinks, launch and recovery, ground support equipment. **3B Components of Unmanned Aircraft Systems (UAS)** • The purpose of the following UAS components: o motor or powerplant o radar positioning o propeller o accelerometers o failsafe function o first-person view (FPV) live video transmission o light-emitting diode (LED) flight indicators o remote control system o collision avoidance technology. **3C Benefits and limitations of a range of cameras and other imaging systems used in UAS technology** • The types of imaging systems associated with UAS: integrated, removable, types of optical and digital resolution, imaging wavelengths (visual, ultra-violet, infra-red). • The benefits and limitations of cameras and other imaging systems used for military weapon targeting, surveillance, mapping, security and policing, film and television production such as keeping law enforcement/troops at a safe distance during surveillance/military targeting operations, use in terrain mapping in hostile/hard-to-reach locations, used as required to get 'closer to the action'. • The types of gimbals used to support cameras and imaging systems including two-axis and three-axis, servo, brushless.
Learning outcome 4: Understand the safety, regulatory and social restrictions of Unmanned Aircraft Systems
4A Factors that allow UAS flying activities to be managed safely • The influence of flight distance, visibility, weather, flight altitude, endurance, weight on safe flying activities. **4B Legal regulations for UAS flying activities** • The effects of regulation including no-fly zones, urban areas, avoiding manned aviation and other aircraft, airports, altitude, distance, registration, personal privacy restrictions.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 17: Principles of Aircraft Flight

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Large, modern passenger and transport aircraft can weigh more than 500,000 kg when they fly fully laden, yet this mass is lifted into the air with apparent ease. Light aircraft and military jet fighters are designed to be very manoeuvrable.

In this unit, you will gain an understanding of the atmosphere in which aircraft fly and the mechanical and fluid principles associated with their flight. You will explore the effects of airflow over aerodynamic surfaces, as well as how lift and drag are generated and how they interact during flight. Finally, you will gain an understanding of the nature of stability and control, and the methods used to stabilise and control fixed-wing aircraft.

Studying this unit will help you to progress to aircraft engineering technician roles in aerospace manufacture, maintenance, component overhaul and repair. It will also help you progress to higher education.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the generation and interaction of aircraft lift and drag forces	1.1 Describe aspects of Bernoulli and Venturi principles and their relationship to lift force generation 1.2 Describe aspects of the types of drag 1.3 Describe aspects of the factors that affect drag forces to achieve the optimum lift/drag 1.4 Describe aspects of how combined couples react to sustain straight and level flight 1.5 Describe aspects of the performance of an aircraft during a type of flight/manoeuvre 1.6 Calculate the lift/drag of a given wing planform

Learning outcomes	Assessment criteria
2. Understand how aircraft stability and control are achieved	2.1 Define one type of stability 2.2 Describe aspects of the methods used to adjust aircraft stability 2.3 Describe the purpose of one primary control 2.4 Describe the purpose of one secondary control 2.5 Describe the purpose of one lift augmentation device 2.6 Describe the purpose of one drag-inducing device
3. Understand the application of high-speed flight	3.1 Describe aspects of the shockwaves formed during transonic flight 3.2 Describe one problem caused by flight in the transonic range 3.3 Describe one design feature used to overcome problems caused by flight in the transonic range 3.4 Describe aspects of the nature of shockwaves at supersonic speed

Unit content

What needs to be learned
Learning outcome 1: Understand the generation and interaction of aircraft lift and drag forces
1A Bernoulli and Venturi principles, their relationship to the generation of lift and the factors that affect lift generation • Bernoulli and Venturi principles and their relationship to lift force generation. • Factors affecting aircraft lift – aerofoil shape, lift coefficient, changing angle of attack, air density and airspeed. • Laminar and turbulent flow. • Boundary layer thickness and separation. **1B Types of drag and the factors that affect drag forces to achieve the optimum lift/drag** • Types of drag and the factors that affect them including: o parasite drag – caused by the motion of an object through a fluid o induced drag – a by-product of lift, as lift increases, induced drag increases o form drag – caused by the shape of the object moving through a fluid o streamlined objects have less form drag than bluff objects o skin friction drag – caused by friction between molecules of the fluid and the skin of an object o interference drag – caused by the interaction of two or more fluid flows having different speeds as they flow around an object o interference drag increases if the angle between the two fluid flows is greater than 90 degrees o rough skin causes greater skin friction drag than a smooth skin. • How total drag is influenced by lift-dependent and non-lift-dependent drag. • How hoar frost, rim ice, glaze ice affect the drag with respect to the following: o aerofoil shape o drag o weight. • Interaction between lift and drag.

What needs to be learned

1C Lift, weight, thrust and drag force combinations and how combined couples react to sustain straight and level flight

- Interaction of the following forces in terms of flight couples: lift, weight, thrust, drag; flight couples (lift/weight, thrust/drag).
- Actions of forces and force couples in straight and level flight.

1D Performance of an aircraft during types of flight and manoeuvre

- Forces acting on an aircraft in a steady turn.
- Load factor during the following manoeuvre types:
  - climb, cruise, dive and pull-out from a dive.
- Application of the load factor and flight envelopes in relation to manoeuvre, gust, operating strength limitations, design speeds, angle of attack position and stall conditions.

1E Characteristics of basic wing planforms

- Wing planform designs such as rectangular, elliptical, straight, tapered, swept, delta.
- Calculation of lift and drag for different planforms.

Learning outcome 2: Understand how aircraft stability and control are achieved

2A Static and dynamic stability

- Reaction to a disturbance for stable, unstable and neutrally stable bodies.
- Definition of static stability: the ability of an aircraft to return to a steady level state after it has been deflected by a transient disturbance.
- Definition of dynamic stability: the form of motion an aircraft in static stability undergoes when it tries to return to its original position.

2B Methods for adjusting aircraft lateral stability, longitudinal stability and directional stability

- Methods of controlling aircraft stability in all three axes.
- Lateral stability – lateral dihedral wing angles, high/low wing position in relation to the fuselage, wing sweep.
- Directional stability – fin, fuselage and dorsal/ventral fins, wing sweep.
- Longitudinal stability – tail plane, horizontal stabiliser.

2C Purpose and operation of primary and trim controls

- Purpose of primary control surfaces: ailerons, elevators, rudder.
- Operation of trim controls.

What needs to be learned

2D Purpose and operation of secondary controls

- Purpose of secondary control surfaces: canards, spoilers, elevons, tailerons, flaperons.
- Operation of secondary control surfaces: canards, spoilers, elevons, tailerons, flaperons.

2E Purpose and operation of lift augmentation devices and drag-inducing devices

- Purpose and operation of the following lift augmentation devices:
  - slats
  - flaps
    - plain
    - split
    - fowler
    - blown
    - Krüeger.
- Purpose and operation of drag-inducing devices: airbrakes and lift dumps.

Learning outcome 3: Understand the application of high-speed flight

3A Production, effects and behaviour of shockwaves formed during transonic flight

- Transonic airflow in terms of compressible flow, transonic range, speed of sound, Mach number, critical Mach number, formation of shockwave, shock stall, flow through shockwave, Doppler effect.
- Behaviour of a shockwave, centre of pressure and airflow during transonic flight.
- Changes to lift and drag acting on the aircraft in the transonic region.

3B Problems and design features in transonic range

- Problems caused by flight in transonic range: buffeting, shock stall, loss of control effectiveness, Mach tuck.
- Design features to alleviate problems: low-camber and high-speed aerofoil sections, area ruling, sweepback.

3C Nature of the oblique and normal shockwaves at supersonic speed

- Formation of the oblique and normal shockwaves around the aircraft.
- Airflow through the oblique and normal shockwaves over the wing – perpendicular, inclined.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 18: Principles of Rotorcraft

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Over 2,000 years ago, people in the Far East played with a spinning top that consisted of a propeller attached to a stick, which when spun rapidly with your hands would fly off into the air. During the 15th century, Leonardo Da Vinci designed the 'aero screw'. The first powered models driven by rubber bands, designed by Sir George Cayley, flew in 1796. Modern helicopters, however, were developed only after the Second World War due to the invention of key components that overcame the complexity of rotary wing flight.

In this unit, you will develop knowledge of aerodynamics applied to rotary wing aircraft and how this influences helicopter flight. In addition to the terminology and concepts such as dissymmetry of lift, Coriolis effect and vortex ring state, you will explore how helicopter controls function and operate to maintain safe and steady flight. Finally, you will look at helicopters in military use and in maritime and land-based operating theatres. This includes how the design of the helicopter influences its suitability for certain roles and mission types.

This unit will help to prepare you for a career in aircraft engineering or the aviation industry. It can also help you to find work as an apprentice aircraft technician. Alternatively, you could choose to continue your studies in higher education.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the aerodynamic fundamentals that apply to helicopter flight	1.1 Describe aspects of the aerodynamic forces that affect helicopter flight 1.2 Describe one type of flight mode for a helicopter 1.3 Describe aspects of the effect of rotational/gyroscopic forces on helicopter flight

Learning outcomes	Assessment criteria
2. Understand the principles of helicopter flight control	2.1 Describe the purpose of one helicopter flight control 2.2 Describe aspects of main rotor systems 2.3 Describe aspects of anti-torque systems
3. Know the configuration and function of civil and military helicopter systems	3.1 Describe aspects of the relationship between the configuration and function of one military helicopter's airframe and engines 3.2 Describe aspects of the configuration of a military helicopter to ensure platform protection and survivability
4. Know the different types, roles and capabilities of operational military helicopters	4.1 Describe aspects of the different roles for one type of military helicopter

Unit content

What needs to be learned
Learning outcome 1: Understand the aerodynamic fundamentals that apply to helicopter flight

1A Aerodynamic forces that affect flight
• Aerodynamic forces thrust, drag, weight and lift act on a rotary wing aircraft.
• Interaction between four forces of flight, thrust, drag, weight and lift to achieve motion in the following flight modes:
  o hover
  o vertical flight
  o horizontal flight (forwards, rearward, roll left and right and yaw)
  o autorotation.
1B Rotational and gyroscopic forces and helicopter flight
• Effects of a spinning mass on a helicopter:
  o coning angle
  o Coriolis effect
  o translational lift
  o dissymmetry of lift
  o gyroscopic precession.

Learning outcome 2: Understand the principles of helicopter flight control
2A Purpose of flight controls • Collective lever achieves pitch and lift control. • Collective lever achieves thrust control. • Cyclic stick achieves pitch and roll control. • The rudder achieves yaw and heading control. • The governor and correlator maintain rotor rpm. **2B Main rotor systems** • Rotor configurations: single, tandem and side-by-side. • Rotor head types in terms of rigid, semi-rigid, fully articulated. • Rotor head designs in terms of hinges, dampers, swashplates, freewheeling unit.

What needs to be learned

2C Anti-torque systems
• Anti-torque system configuration:
  o open tail rotor
  o Fenestron
  o No tail rotor (NOTAR).

Learning outcome 3: Know the configuration and function of civil and military helicopter systems
3A Configuration and function of civil helicopters' airframes and engines • Fuselage, tail boom, empennage (tail rotor, vertical fin and horizontal tailplane) such as Robinson R22, MD250, Airbus H135, AW189. • Configuration of the engine layout varies with the function of a helicopter: single, dual or triple engines such as AW189, Bell 505, Airbus H135, Robinson R22. **3B Configuration of military helicopters in terms of platform protection and survivability** • Configuration of military helicopters' platform protection and survivability in terms of: o armour/ballistic protection, heat signature reduction, radio and radar warning systems, countermeasures/defensive aids systems.
Learning outcome 4: Know the different types, roles and capabilities of operational military helicopters

4A Different roles of various military helicopters
• Suitability, advantages and limitations of various helicopter types for different military roles:
  o single rotor helicopters
  o twin rotor helicopters.
• Differences between maritime and land-based military helicopters with regards to:
  o Chinook support helicopter and Puma medium support helicopter fulfil their roles for 'lift' in terms of troop movement, cargo, casualty evacuation, combat search and rescue
  o Wildcat multirole helicopter fulfils its role in terms of attack, reconnaissance, air tactical observation and fire direction, cargo, troop movement and fleet replenishment at sea support.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

Unit 19: Space Exploration

Level: 3

Unit type: Optional

Guided learning hours: 30

Unit introduction

Space exploration is becoming more and more achievable with the continuous advancements in computing technology, spacecraft and their propulsion systems. No longer are we limited to our solar system or just orbiting planets. These advancements have allowed us to land spacecraft on asteroids and planets that we never thought would be possible.

In this unit, you will learn about our solar system and our nearest planetary neighbours. From there you will go on to gain knowledge of various objects in our universe, such as stars, black holes and neutron stars. You will investigate how we gain knowledge of these universal objects through the use of telescopes. Finally, you will study methods of capturing images and the impact of the Earth's atmosphere on these images we receive using optical and electromagnetic imaging devices.

Learning outcomes and assessment criteria

To pass this unit, learners need to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1. Understand the objects in our solar system	1.1 Describe aspects of one major body in the solar system 1.2 Describe aspects of the conditions on the moons that may contain water and life 1.3 Describe aspects of the importance of one scientific mission 1.4 Describe aspects of the importance of the Artemis mission 1.5 Describe aspects of how one scientific mission contributed to our understanding of space

Learning outcomes	Assessment criteria
2. Understand the lifespan of different objects in the universe	2.1 Describe aspects of the lifecycle of a star 2.2 Describe aspects of a neutron star 2.3 Describe aspects of a black hole 2.4 Describe aspects of Cepheid variables 2.5 Describe aspects of the structure of the Sun
3. Understand the development and structure of the telescope	3.1 Describe aspects of one type of telescope 3.2 Describe aspects of the history of the telescope 3.3 Describe aspects of the optics required for a telescope to form images 3.4 Describe aspects of one effect of the atmosphere on imaging from Earth
4. Understand the significance of space instrumentation and imaging	4.1 Describe aspects of the sensitivity of a telescope to regions of the electromagnetic spectrum 4.2 Describe aspects of the function of a charged coupled device (CCD) 4.3 Describe aspects of the function of the CubeSat 4.4 Describe aspects of the function of a mass spectrometer

Unit content

What needs to be learned
Learning outcome 1: Understand the objects in our solar system

1A The major bodies in the solar system
• Differences between a gas planet and a rocky planet.
• Jupiter's gravitational field protection of the Earth from asteroids.
• Classification of the eight planets of the solar system: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.
• The definitions of the following:
  o interstellar
  o heliosphere
  o Oort cloud.
1B The moons Enceladus, Titan, Europa and Ganymede in the solar system and why these may contain water and subsequently life
• Atmospheric conditions of each of these moons compared to Earth's atmosphere.
• Basic conditions of an atmosphere to be able to support life.
1C The importance of scientific missions
• Aims of:
  o Rosetta mission
  o ExoMars missions
  o LUVMI rover mission.
1D The importance of future scientific missions
• Aim of the Artemis mission.
1E How these missions have contributed to our understanding of space
• The scientific impact of:
  o Rosetta mission
  o ExoMars mission
  o LUVMI rover mission.

Learning outcome 2: Understand the lifespan of different objects in the universe
2A The lifecycle of a star • Function of gravity in creating protostars in a stellar nursery.

What needs to be learned
• Force balance between gravity and nuclear fusion to create a main sequence star. • Process in which certain stars become red giants or red super giants. • Process when a star dies. • Creation of heavy elements by a supernova. **2B Neutron star** • Celestial object of very small radius (typically 30 km) and very high density, composed predominantly of closely packed neutrons. • Force balance changes involved when a neutron star is created. • Different types of neutron star including magnetars and pulsars. **2C The important features of a black hole** • Definition: a place in space where gravity pulls so much that light cannot get out because matter has been squeezed into a tiny space. • The formation of a black hole. • Impact of solar mass on the formation of a black hole. • Effects of gravity on characteristics of a black hole. **2D Cepheid variables and their importance in measuring cosmic distances** • The luminosity and astronomical unit used. • The use of Cepheid variables to measure distances including: the period of fluctuations in brightness, types of Cepheid variable stars, absolute magnitude, apparent magnitude. **2E The structure of the Sun and its lifespan** • The lifecycle of a main sequence star. • Structure – core, radiation zone, convection zone, photosphere, chromosphere, corona.
Learning outcome 3: Understand the development and structure of the telescope
3A The types and function of a telescope • Significance of collecting faint light from an astronomical source. • How a telescope focuses light to form an image. • Types of telescope: reflector, catadioptric, refractor, gamma-ray, Specific Wavelength-sensitive Telescopes.

What needs to be learned
• Optical design of the refractor telescope, reflector telescope and catadioptric telescope. **3B The history and early discoveries of the telescope** • Invention of glass and study of optical properties of glass. • Observation of Jupiter by Galileo. • Observation of three of the Galilean satellites. **3C The optics required for a telescope to form images** • Difference between convex and concave lenses. • Difference between convex and concave mirrors. **3D The effect of the atmosphere on imaging from Earth** • Significance of atmospheric turbulence. • Effect of the atmosphere on the Hubble telescope. • Function of orbital geometry.
Learning outcome 4: Understand the significance of space instrumentation and imaging
4A Visible, ultra violet (UV) and infrared (IR) astronomy • Regions of the electromagnetic spectrum. • Types of telescope such as radio, ultraviolet, X-ray, infrared, refracting, reflecting, catadioptric and their sensitivity to different regions of the electromagnetic spectrum. **4B How images are captured in space** • Function of charged coupled devices (CCD): o contain a large number of light-sensitive areas (pixels) which can be used to build up an image o photons of light fall within the area defined by one or more pixels and are converted into a number of electrons proportional to the intensity of the photon which are used to recreate the image. • End of life of space missions is in part caused by radiation damage to image sensors. **4C The requirements for Earth observation** • The function of the CubeSat: o enables low-cost experiments to be launched into space as small satellites o allows academics to design, build, test, launch and operate satellites for research.

What needs to be learned

4D How instruments on probes are used to analyse composition of materials in space

- Basic function of a mass spectrometer.
- Enables the analysis of the components of a sample by separating them by their mass and electrical charge.
- Stages of analysis:
  - ionisation of the sample
  - acceleration of the ions to form a focused beam and to give all elements the same kinetic energy
  - deflection of the ions by a magnetic field – light ions deflect more than heavier ions
  - detectors count the number of ions at different deflections and plot the data on a graph.

Essential information for tutors and assessors

Essential resources

There are no special resources needed for this unit.

Assessment

The unit is assessed by the centre and will be subject to external verification by Pearson. Achievement of the assessment criteria should be evidenced through contextualised, vocationally related experiences and be specifically designed with the assessment and grading criteria in mind.

10 Appeals

Centres must have a policy for dealing with appeals from learners. Appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy is a consideration of the evidence by a Lead Internal Verifier or other member of the programme team. The assessment plan should allow time for potential appeals after learners have been given assessment decisions.

Centres must document all learners' appeals and their resolutions. Further information on the appeals process can be found in the document *Internal assessment in vocational qualifications: Reviews and appeals policy*, available on our website.

11 Malpractice

Dealing with malpractice in assessment

Malpractice refers to acts that undermine the integrity and validity of assessment, the certification of qualifications and/or may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actual or attempted actions of malpractice by learners, centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, centre staff or centres where malpractice or attempted malpractice has been proven.

Malpractice may occur or be suspected in relation to any unit or type of assessment within a qualification. For further details on malpractice and advice on preventing malpractice by learners, please see Pearson's *Centre Guidance: Dealing with Malpractice*, available on our website.

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. The *Centre Guidance: Dealing with Malpractice* document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe a centre is failing to conduct internal assessment according to our policies. The above document gives further information and examples. It details the penalties and sanctions that may be imposed.

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

Learner malpractice

The head of centre is required to report incidents of suspected learner malpractice that occur during Pearson qualifications. We ask centres to complete *JCQ Form M1* (www.jcq.org.uk/malpractice) and email it with any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc) to the Investigations Processing team at candidatemalpractice@pearson.com. The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Teacher/centre malpractice

The head of centre is required to inform Pearson's Investigations team of any incident of suspected malpractice (which includes maladministration) by centre staff before any investigation is undertaken. The head of centre is requested to inform the Investigations team by submitting a *JCQ M2* Form (downloadable from www.jcq.org.uk/malpractice) with supporting documentation to pqsmalpractice@pearson.com. Where Pearson receives allegations of malpractice from other sources (for example Pearson staff, anonymous informants), the Investigations team will conduct the investigation directly or may ask the head of centre to assist.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results/certificates while an investigation is in progress. Depending on the outcome of the investigation, results and/or certificates may not be released or they may be withheld.

You should be aware that Pearson may need to suspend certification when undertaking investigations, audits and quality assurances processes. You will be notified within a reasonable period of time if this occurs.

Sanctions and appeals

Where malpractice is proven, we may impose sanctions or penalties, such as:

- mark reduction for affected external assessments
- disqualification from the qualification
- debarment from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures we may impose sanctions such as:

- working with centres to create an improvement action plan
- requiring staff members to receive further training
- placing temporary suspensions on certification of learners
- placing temporary suspensions on registration of learners
- debarring staff members or the centre from delivering Pearson qualifications
- suspending or withdrawing centre approval status.

The centre will be notified if any of these apply.

Pearson has established procedures for considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from the head of centre (on behalf of learners and/or members or staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in the *JCQ Appeals booklet* (www.jcq.org.uk/exams-office/appeals).

12 Further information and publications

- Edexcel, BTEC and Pearson Work Based Learning contact details: qualifications.pearson.com/en/contact-us.html.
- Books, software and online resources for UK schools and colleges: www.pearsonschoolsandfecolleges.co.uk.
- Our publications catalogue lists all the material available to support our qualifications. To access the catalogue and order publications, please visit our website.

All centres offering external assessments must comply with the Joint Council for Qualifications (JCQ) document *Instructions for conducting examinations.*

Further documents that support the information in this specification:

- *Access arrangements and reasonable adjustments* (JCQ)
- *A guide to the special consideration process* (JCQ)
- *Collaborative and consortium arrangements for the delivery of vocational qualifications policy* (Pearson)
- *UK information manual* (updated annually and available in hard copy) **or** *Entries and information manual* (available online) (Pearson).
- *Distance learning and assessment policy* (Pearson)

Publisher information

Any publisher can seek endorsement for their resources and, if they are successful, we will list their BTEC resources on our website.

13 Glossary

Part A – General terminology used in specification

Term	Description
Level	Units and qualifications have a level assigned to them. The level assigned is informed by the level descriptors defined by Ofqual, the qualifications regulator.
Guided learning hours (GLH)	This indicates the number of hours of activities that directly or immediately involve tutors and assessors in teaching, supervising, and invigilating learners, for example lectures, tutorials, online instruction and supervised study. Units may vary in size.
Total qualification time (TQT)	This indicates the total number of hours that a typical learner will take to complete the qualification. This is in terms of both guided learning hours but also unguided learning, for example private study, time spent in the workplace to master skills.
Learning outcomes	The learning outcomes of a unit set out what a learner knows, understands or is able to do as the result of a process of learning.
Assessment criteria	The assessment criteria specify the standard the learner is required to meet to achieve a learning outcome.
Unit content	This section sets out the required teaching content of the unit and specifies the knowledge, skills and understanding required for achievement of the unit. It enables centres to design and deliver a programme of learning that will enable learners to achieve each learning outcome and to meet the standard determined by the assessment criteria.
Summative assessment	Assessment that takes place after the programme of learning has taken place.
Valid assessment	The assessment assesses the skills or knowledge/understanding in the most sensible, direct way to measure what it is intended to measure.
Reliable assessment	The assessment is consistent and the agreed approach delivers the correct results on different days for the same learners and different cohorts of learners.

Part B – Terms used in knowledge and understanding criteria

Term	Description
Describe	Give a clear account in their own words, including all the relevant information (e.g. qualities, characteristics or events, etc). Description shows recall and in some cases application.
Explain	Provide details and give reasons and/or evidence to support an opinion, view or argument. **OR** Provide details and give relevant examples to clarify and extend a point. This would usually be in the context of learners showing their understanding of a technical concept or principle.
Identify	Shows the main features or purpose of something. Can recognise it and/or name characteristics or facts that relate to it.
Outline	Provide a summary or overview or brief description.
State	Express information in clear and precise terms.

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For information about Pearson qualifications, including Pearson Edexcel, BTEC and LCCI qualifications visit qualifications.pearson.com