Aerospace Systems 2025 v1.0

General senior syllabus

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Queensland Government

QCAA Queensland Curriculum & Assessment Authority

For all Queensland schools

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Queensland syllabuses for senior subjects

In Queensland, a syllabus for a senior subject is an official 'map' of a senior school subject. A syllabus's function is to support schools in delivering the Queensland Certificate of Education (QCE) system through high-quality and high-equity curriculum and assessment.

Syllabuses are based on design principles developed from independent international research about how excellence and equity are promoted in the documents teachers use to develop and enliven the curriculum.

Syllabuses for senior subjects build on student learning in the Prep to Year 10 Australian Curriculum and include General, General (Extension), Senior External Examination (SEE), Applied, Applied (Essential) and Short Course syllabuses.

More information about syllabuses for senior subjects is available at www.qcaa.qld.edu.au/senior/senior-subjects and in the 'Queensland curriculum' section of the *QCE and QCIA policy and procedures handbook*.

Teaching, learning and assessment resources will support the implementation of a syllabus for a senior subject. More information about professional resources for senior syllabuses is available on the QCAA website and via the QCAA Portal.

Course overview

Rationale

Technologies have been an integral part of society for as long as humans have had the desire to create solutions to improve their own and others' quality of life. Technologies have an impact on people and societies by transforming, restoring and sustaining the world in which we live.

Australia needs enterprising and innovative individuals with the ability to make discerning decisions concerning the development, use and impact of technologies. When developing technologies, these individuals need to be able to work independently and collaboratively to solve complex, open-ended problems. Subjects in the Technologies learning area prepare students to be effective problem-solvers as they learn about and work with contemporary and emerging technologies.

Students who study Aerospace Systems learn about the fundamentals, history and future of the aerospace industry. They gain knowledge of aeronautics, aerospace operations, safety management systems (including human factors), and systems thinking, enabling them to solve real-world aerospace problems using the problem-solving process in Aerospace Systems.

In this subject, students use systems thinking habits, systems thinking strategies, and aerospace technology knowledge, concepts and principles to explore problems and develop solutions. Students learn to understand and interpret the relationships between and within connected systems and their component parts. They identify patterns in problematic aerospace systems situations and make proposals concerning solutions. This learnt ability provides students with the higher order cognitive capacity to engage with problems that exist in an exciting and dynamic technological world. Students develop and use skills that include analysis, decision-making, justification, recognition, comprehension and evaluation to develop solutions to aerospace problem situations. Students become self-directed learners and develop beneficial collaboration and management skills as they solve aerospace systems problems.

Students learn transferrable 21st century skills that support their life aspirations, including critical thinking, creative thinking, communication, collaboration and teamwork, personal and social skills, and information & communication technologies (ICT) skills. Students become adaptable and resilient through their problem-solving learning experiences, improving their ability to interpret events, analyse situations and comprehend cause-and-effect relationships. Through their study of Aerospace Systems, students appreciate that short-term fixes may have long-term implications. Students recognise the complexity of global, national and local community problem situations and understand the challenges faced in generating sustainable and durable solutions.

Syllabus objectives

The syllabus objectives outline what students have the opportunity to learn.

1. **Recognise and describe aerospace systems problems, knowledge, concepts and principles.**

   When students recognise aerospace systems problems, knowledge, concepts and principles they identify or recall related aerospace technology knowledge, including mathematic calculations and scientific concepts and principles to acknowledge the characteristics of problems, the areas of possible weakness and the relationships between systems, subsystems and system components. Students describe by giving an account of the characteristics or features of problems, knowledge, concepts and principles.

2. **Symbolise and explain ideas, solutions and relationships.**

   When students symbolise, they represent idea and solution development, and relationships using visual frameworks, causal loop diagrams, flow charts, diagrams, sketches and pictures. When students explain, they use knowledge, understanding and reasoning to make ideas, solutions and the relationships between aerospace systems and system components plain or clear by describing them in more detail or revealing relevant facts.

3. **Analyse problems and information.**

   When students analyse problems and information, they research and investigate to explain and interpret, for the purpose of finding meaning or relationships. They determine the reasonableness of information and ascertain patterns, similarities and differences in order to identify elements, components and features, and their relationship to the structure of problems.

4. **Determine solution success criteria for aerospace problems.**

   When students determine solution success criteria for aerospace problems, they establish, conclude or ascertain solution requirements after consideration of elements, components and features, and their relationship to the structure of problems.

5. **Synthesise information and ideas to propose possible solutions.**

   When students synthesise information and ideas to propose possible solutions, they combine and integrate information and ideas and resolve uncertainties using knowledge gained through investigation, collaboration and testing to create new understanding.

6. **Generate solutions to provide data to determine the feasibility of proposals.**

   When students generate solutions, they produce or simulate a solution that, when tested, provides data to determine the proposal's capability to be reasonably achieved.

7. **Evaluate and refine ideas and solutions to make justified recommendations.**

   When students evaluate, they appraise ideas and solutions by weighing up or assessing strengths, implications and limitations against success criteria. When students refine ideas and solutions, they modify to make improvements relative to success criteria. They use data, provided by testing, to evaluate and refine ideas and solutions. When students make justified recommendations, they put forward a point of view or suggestion with supporting evidence to make modifications or enhancements.

8. **Make decisions about and use mode-appropriate features, language and conventions for particular purposes and contexts.**

   When students make decisions about mode-appropriate features and conventions, they use written, visual, and spoken features to express meaning for particular purposes in a range of contexts. Written communication includes language conventions, specific vocabulary and language features such as annotations, paragraphs and sentences. Visual communication includes photographs, sketches, drawings, diagrams and motion graphics. Spoken communication includes verbal and nonverbal features and may be for live or virtual audiences. Students use referencing conventions to practise ethical scholarship for particular purposes.

Designing a course of study in Aerospace Systems

Syllabuses are designed for teachers to make professional decisions to tailor curriculum and assessment design and delivery to suit their school context and the goals, aspirations and abilities of their students within the parameters of Queensland's senior phase of learning.

The syllabus is used by teachers to develop curriculum for their school context. The term *course of study* describes the unique curriculum and assessment that students engage with in each school context. A course of study is the product of a series of decisions made by a school to select, organise and contextualise subject matter, integrate complementary and important learning, and create assessment tasks in accordance with syllabus specifications.

It is encouraged that, where possible, a course of study is designed such that teaching, learning and assessment activities are integrated and enlivened in an authentic setting.

Course structure

Aerospace Systems is a General senior syllabus. It contains four QCAA-developed units from which schools develop their course of study.

Each unit has been developed with a notional time of 55 hours of teaching and learning, including assessment.

Students should complete Unit 1 and Unit 2 before beginning Units 3 and 4. Units 3 and 4 are studied as a pair.

More information about the requirements for administering senior syllabuses is available in the 'Queensland curriculum' section of the *QCE and QCIA policy and procedures handbook*.

Curriculum

Senior syllabuses set out only what is essential while being flexible so teachers can make curriculum decisions to suit their students, school context, resources and expertise.

Within the requirements set out in this syllabus and the *QCE and QCIA policy and procedures handbook*, schools have autonomy to decide:

- how and when subject matter is delivered
- how, when and why learning experiences are developed, and the context in which learning occurs
- how opportunities are provided in the course of study for explicit and integrated teaching and learning of complementary skills.

These decisions allow teachers to develop a course of study that is rich, engaging and relevant for their students.

Assessment

Senior syllabuses set out only what is essential while being flexible so teachers can make assessment decisions to suit their students, school context, resources and expertise.

General senior syllabuses contain assessment specifications and conditions for the assessment instruments that must be implemented with Units 3 and 4. These specifications and conditions ensure comparability, equity and validity in assessment.

Within the requirements set out in this syllabus and the *QCE and QCIA policy and procedures handbook*, schools have autonomy to decide:

- specific assessment task details
- assessment contexts to suit available resources
- how the assessment task will be integrated with teaching and learning activities
- how authentic the task will be.

In Unit 1 and Unit 2, schools:

- develop at least two but no more than four assessments
- complete at least one assessment for each unit
- ensure that each unit objective is assessed at least once.

In Units 3 and 4, schools develop three assessments using the assessment specifications and conditions provided in the syllabus.

More information about assessment in senior syllabuses is available in 'The assessment system' section of the *QCE and QCIA policy and procedures handbook*.

Subject matter

Each unit contains a unit description, unit objectives and subject matter. Subject matter is the body of information, mental procedures and psychomotor procedures (see Marzano & Kendall 2007, 2008) that are necessary for students' learning and engagement with the subject. Subject matter itself is not the specification of learning experiences but provides the basis for the design of student learning experiences.

Subject matter has a direct relationship with the unit objectives and provides statements of learning that have been constructed in a similar way to objectives.

Aboriginal perspectives and Torres Strait Islander perspectives

The QCAA is committed to reconciliation. As part of its commitment, the QCAA affirms that:

- Aboriginal peoples and Torres Strait Islander peoples are the first Australians, and have the oldest living cultures in human history
- Aboriginal peoples and Torres Strait Islander peoples have strong cultural traditions and speak diverse languages and dialects, other than Standard Australian English
- teaching and learning in Queensland schools should provide opportunities for students to deepen their knowledge of Australia by engaging with the perspectives of Aboriginal peoples and Torres Strait Islander peoples
- positive outcomes for Aboriginal students and Torres Strait Islander students are supported by successfully embedding Aboriginal perspectives and Torres Strait Islander perspectives across planning, teaching and assessing student achievement.

Guidelines about Aboriginal perspectives and Torres Strait Islander perspectives and resources for teaching are available at www.qcaa.qld.edu.au/k-12-policies/aboriginal-torres-strait-islander-perspectives.

Where appropriate, Aboriginal perspectives and Torres Strait Islander perspectives have been embedded in the subject matter.

Complementary skills

Opportunities for the development of complementary skills have been embedded throughout subject matter. These skills, which overlap and interact with syllabus subject matter, are derived from current education, industry and community expectations and encompass the knowledge, skills, capabilities, behaviours and dispositions that will help students live and work successfully in the 21st century.

These complementary skills are:

- literacy — the knowledge, skills, behaviours and dispositions about language and texts essential for understanding and conveying English language content
- numeracy — the knowledge, skills, behaviours and dispositions that students need to use mathematics in a wide range of situations, to recognise and understand the role of mathematics in the world, and to develop the dispositions and capacities to use mathematical knowledge and skills purposefully
- 21st century skills — the attributes and skills students need to prepare them for higher education, work, and engagement in a complex and rapidly changing world. These skills include critical thinking, creative thinking, communication, collaboration and teamwork, personal and social skills, and digital literacy. The explanations of associated skills are available at www.qcaa.qld.edu.au/senior/senior-subjects/general-subjects/21st-century-skills.

It is expected that aspects of literacy, numeracy and 21st century skills will be developed by engaging in the learning outlined in this syllabus. Teachers may choose to create additional explicit and intentional opportunities for the development of these skills as they design the course of study.

Additional subject-specific information

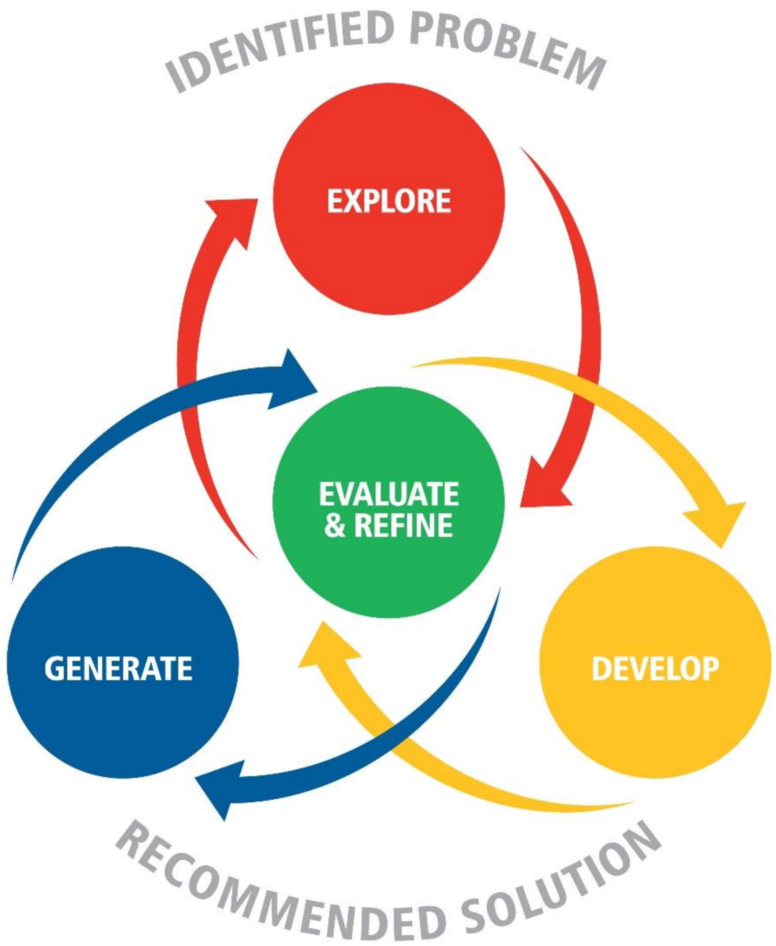
Additional subject-specific information has been included to support and inform the development of a course of study.

Procedural knowledge

This procedural knowledge must be integrated into the subject matter and assessment of all units. Each of the units in Aerospace Systems requires the problem-solving process given its analytical and technical in nature. The process is iterative and proceeds through a number of phases, requiring students to recognise and describe aerospace problems. Students examine problem-related systems, subsystems and system components to recognise structure and comprehend relationships so they can determine solution success criteria. Students use systems thinking habits and systems thinking strategies, and aerospace technology knowledge, concepts and principles to develop, test and refine a range of possible solutions. Students decide on a feasible solution to the original aerospace systems problem, and evaluate the proposed solution using success criteria and justify recommendations for future improvements.

The problem-solving process in Aerospace Systems involves student engagement with the four phases of explore, develop, generate, and evaluate and refine.

Figure 1: The problem-solving process in Aerospace Systems



To explore the problem, students:

- recognise and describe characteristics of the problem in relation to related aerospace systems, subsystems and system components
- symbolise the incorporated aerospace systems using visual frameworks, including systems diagrams and models
- research and investigate similar situations to understand the nature of the problem
- analyse contributing factors and areas of weakness to identify the elements, components and features, and their relationship to the structure of the problem
- recognise and describe causes and effects using causal loops and feedback loops
- communicate and discuss with others and team members
- determine solution success criteria considering the elements, components and features, and their relationship to the structure of the problem.

To develop ideas, students:

- investigate historic solutions and analyse positive and negative consequences
- research and investigate the application of potential future aerospace technologies and technologies in related fields
- analyse aeronautical data about the problem, e.g. charts, publications, operation information (logs and manuals), surveys, interviews and experiments
- collaborate with team members or others to brainstorm ideas for possible solutions
- symbolise and explain synthesis of ideas using visual frameworks, feedback loops, flow charts, diagrams, sketches and pictures
- evaluate and refine ideas in relation to solution success criteria
- graphically represent the relationship between various ideas and solution success criteria, e.g. PMI (plus, minus, interesting) charts
- propose possible short- and long-term outcomes
- gain feedback on possible solutions, e.g. surveys or interviews
- propose a solution.

To generate solutions, students:

- generate the proposed solution for testing
- test, simulate or hypothetically apply the proposed solution in the original problem situation to provide data
- evaluate the appropriateness of the proposed solution through collaboration with team members or industry experts using the success criteria
- refine the solution to match with solution success criteria
- communicate the solution to a specified audience using oral, written or graphical modes
- implement the solution by producing, simulating or hypothetically applying it in the original problem situation to provide data.

To evaluate and refine, students:

- evaluate the solution and its impact on related systems and system components in relation to the solution success criteria
- determine whether the solution is short- or long-term
- recommend and justify future modifications or enhancements.

Reporting

General information about determining and reporting results for senior syllabuses is provided in the 'Determining and reporting results' section of the *QCE and QCIA policy and procedures handbook*.

Reporting standards

Reporting standards are summary statements that describe typical performance at each of the five levels (A–E).

A
The student, for a range of aerospace situations, demonstrates accurate and discriminating recognition and discerning description of aerospace systems problems, knowledge, concepts and principles; adept symbolisation and discerning explanation of ideas, solutions and relationships. The student demonstrates insightful analysis of problems and relevant information, and astute determination of essential solution success criteria. The student demonstrates coherent and logical synthesis of relevant information and ideas to propose possible solutions; critical evaluation and discerning refinement of ideas and solutions using success criteria to make astute recommendations justified by evidence; purposeful generation of solutions to provide valid data to critically determine the feasibility of proposals; discerning decision-making about, and proficient use of, mode-appropriate features, language and conventions to communicate development of solutions for purpose.
B
The student, for a range of aerospace situations, demonstrates accurate recognition and effective description of aerospace systems problems, knowledge, concepts and principles; methodical symbolisation and effective explanation of ideas, solutions and relationships. The student demonstrates considered analysis of problems and relevant information, and reasoned determination of effective solution success criteria. The student demonstrates logical synthesis of relevant information and ideas to propose possible solutions; reasoned evaluation and effective refinement of ideas and solutions using success criteria to make considered recommendations justified by evidence; effective generation of solutions to provide valid data to effectively determine the feasibility of proposals; effective decision-making about, and fluent use of, mode-appropriate features, language and conventions to communicate development of solutions for purpose.
C
The student, in a range of aerospace contexts, demonstrates appropriate recognition and description of aerospace systems problems, knowledge, concepts and principles; competent symbolisation of and adequate explanation of some ideas, solutions and relationships. The student demonstrates appropriate analysis of problems and information, and logical determination of appropriate solution success criteria. The student demonstrates simple synthesis of information and ideas to propose possible solutions; feasible evaluation and adequate refinement of ideas and solutions using some success criteria to make fundamental recommendations justified by evidence; adequate generation of solutions to provide relevant data to determine the feasibility of proposals; appropriate decision-making about, and use of, mode-appropriate features, language and conventions to communicate development of solutions for purpose.

D
The student, for a range of aerospace situations, demonstrates variable recognition and superficial description of aspects of problems, concepts or principles; variable symbolisation or superficial explanation of aspects of ideas, solutions or relationships. The student demonstrates superficial analysis of problems and partial information, and reasonable determination of some solution success criteria. The student demonstrates rudimentary synthesis of partial information or ideas to propose solutions; superficial evaluation of ideas or solutions using some success criteria to make elementary recommendations; partial generation of solutions to provide elements of data to partially determine the feasibility of proposals; inconsistent decision-making about, and inconsistent use of, mode-appropriate features, language and conventions to communicate.
E
The student, for a range of aerospace situations, demonstrates recognition of aspects of problems, concepts or principles and disjointed symbolisation or explanation of aspects of ideas or solutions. The student demonstrates the making of statements about problems, concepts or principles. The student demonstrates unclear combinations of information or ideas; identification of a change to an idea or a solution; generation of elements of solutions; unclear or fragmented use of mode-appropriate features, language and conventions.

Determining and reporting results

Unit 1 and Unit 2

Schools make judgments on individual assessment instruments using a method determined by the school. They may use the reporting standards or develop an instrument-specific marking guide (ISMG). Marks are not required for determining a unit result for reporting to the QCAA.

The unit assessment program comprises the assessment instrument/s designed by the school to allow the students to demonstrate the unit objectives. The unit judgment of A–E is made using reporting standards.

Schools report student results for Unit 1 and Unit 2 to the QCAA as satisfactory (S) or unsatisfactory (U). Where appropriate, schools may also report a not rated (NR).

Units 3 and 4

Schools mark each of the three internal assessment instruments implemented in Units 3 and 4 using ISMGs.

Schools report a provisional mark by criterion to the QCAA for each internal assessment.

Once confirmed by the QCAA, these results will be combined with the result of the external assessment developed and marked by the QCAA.

The QCAA uses these results to determine each student's subject result as a mark out of 100 and as an A–E.

Units

Unit 1: Introduction to aerospace systems

In Unit 1, students are introduced to the technology, concepts and principles associated with the aerospace industry. They learn about the global, national and local importance of the industry. Students investigate the industry's historical development and consider the challenges associated with meeting the transportation needs and expectations of future societies. Students explore problems associated with the increasing global demand for safe and efficient aircraft, pilots, support staff, maintenance staff and ground and airspace support systems. In this unit, students gain a basic understanding of aerodynamics and aircraft flight systems, concepts and principles such as lift, weight and drag, instability, high- and low-speed flight control, piston and gas turbine engines, electrical supply, control force and fuel delivery. Students gain an understanding of the potential impacts of weather conditions on various aerospace operations and the systems used to mitigate disruption.

Students learn about and use systems thinking habits and systems thinking strategies, such as visual frameworks, causal loops and feedback loops to recognise and classify the interrelationships that exist within and between various aerospace systems.

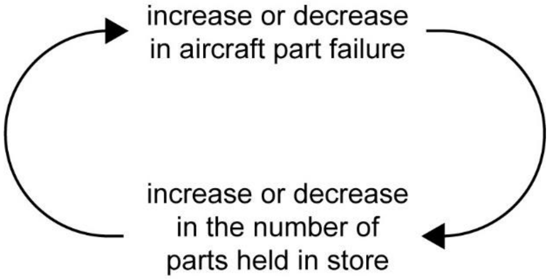
Unit objectives

1. Recognise and describe problems, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aerospace systems and structures.
2. Symbolise and explain ideas, solutions and relationships in relation to aerospace systems and structures.
3. Analyse problems and information in relation to aerospace systems and structures.
4. Determine solution success criteria for aerospace systems and structures problems.
5. Synthesise information and ideas to propose possible aerospace systems and structures solutions.
6. Generate aerospace systems and structures solutions to provide data to determine the feasibility of proposals.
7. Evaluate and refine ideas and solutions to make justified recommendations.
8. Make decisions about and use mode-appropriate features, language and conventions to communicate development of solutions.

Subject matter

Topic 1: Solving aerospace problems

- Recognise and describe the phases of the iterative problem-solving process in Aerospace Systems.
- Recognise teamwork/collaboration skills and strategies, including listening, questioning, persuading, respecting, helping, sharing, participating.
- Describe brainstorming, research and written communication skills.
- Solve basic problems using the problem-solving process in Aerospace Systems, e.g. create a series of paper planes to perform certain in-flight manoeuvres.
- Define a system.
- Recognise and describe examples of aerospace systems, including aircraft and airport safety management systems (including human factors), airport and airline organisational systems and aircraft performance systems.
- Define systems thinking.
- Recognise and describe the Waters Foundation's (2017) fourteen systems thinking habits (looking at the big picture, change over time, systems structure, interdependencies, connections, changes in perspective, assumptions, considering issues fully, mental models, leverage, consequences, accumulations, time delays, and successive approximation).
- Recognise systems thinking strategies, including
  - iceberg visual frameworks
  - feedback loops (balancing and reinforcing)
  - causal loop diagrams
  - bowtie models.
- Define and compare reinforcing and balancing feedback loops.
- Create a causal loop diagram showing feedback within a basic system, e.g. the causal loop diagram below communicates the simplistic warehouse storage system for aircraft spare parts. An increase in failures would require an increase in the number of parts kept in store and a decrease would necessitate a corresponding decrease in the number of parts required. The increase or decrease in one element of the simple warehouse storage system reinforces the increase or decrease in the other.



- Explain the benefits of using reinforcing or balancing feedback loops to solve aerospace problems.

Topic 2: Aerospace industries

- Investigate the major milestones in aerospace, e.g.
  - pre–20th century examples of aerospace concepts, including boomerangs, kites, rockets, balloons, gliders and early attempts at aircraft development
  - materials, including timber, natural fibres, aluminium and modern composite materials
  - power plants, including piston and jet engines
  - pioneers, including international and Australian
  - the evolution of aviation governing and safety organisations
  - the different roles played by various aircraft types at key points in history (1901 to the present).
- Recognise and describe aircraft features and configurations, including wings, tail, undercarriage and engines, and their associated locations.
- Explore aerospace domain concepts, e.g.
  - traditional aircraft
  - rockets
  - drones and remotely piloted aircraft systems (RPAS)
  - defence
  - air traffic control
  - regulations
  - air taxi.
- Explore the historical growth of domestic and international airline carriers and their current and future importance both economically and socially.
- Investigate the historic development of military aerospace technologies and infrastructure to predict future possibilities.
- Explore aerospace industry career pathways, e.g.
  - airside and landside ground operations
  - airspace operations
  - airline manufacturing, maintenance and modifications.

Topic 3: Aerodynamics

- Use the problem-solving process to solve an identified real-world aerodynamics problem.
- Recognise and describe the components of a basic aircraft structure and primary flight controls for fixed- and rotary-wing aircraft.
- Investigate the airframe construction techniques of monocoque and stressed skin.
- Analyse airframe construction materials, including aluminium, aluminium alloys and composite materials.
- Define the forces of lift, weight, thrust and drag and their relationship to each other.
- Explain the theories of generating lift and aerofoils (Newton's third law and Bernoulli's principle).
- Investigate the concepts of angle of attack, types of drag, ground effect, boundary layer, load factor, centre of gravity, centre of pressure (lift), stalls and spins
  - calculate scenarios using the lift and drag equations and use the drag curve, with the following formulas
    - $lift = C_L \frac{1}{2} \rho V^2 A$
    - $drag = C_D \frac{1}{2} \rho V^2 A$
    - $centre\ of\ gravity\ of\ an\ aircraft\ (CG) = \frac{total\ moment}{total\ weight\ (kg)}$
- Compare wing designs, including laminar and conventional aerofoils, angle of incidence, aerofoil variation, aspect ratio and fineness ratio, dihedral and anhedral wings, fences, winglets, slots and slats, spoilers and speed brakes, and flap variations.
- Develop ideas for and create various wing shapes to demonstrate an understanding of lift.
- Conduct experiments on common objects to identify forms that generate lift forces.
- Comprehend the concept of static stability and dynamic stability, including longitudinal, lateral and directional stability.
- Define high-speed flight, e.g. subsonic, transonic and supersonic flight.
- Investigate the primary and secondary effects of controls.

Topic 4: Aircraft systems

- Comprehend the similarities and differences between piston-driven and gas turbine engines.
- Explore propeller design, including variable and fixed pitch.
- Define and explain the operation of the following systems and how they are used in modern aircraft
  - electrical, including simple circuits and components
  - fuel, including types of fuel and basic components
  - hydraulics, including types of fluids and components
  - pneumatics, including air conditioning, pressurisation and components
  - avionics, including communication, navigation and surveillance
  - six primary flight instruments
    - airspeed indicator (pitot static)
    - attitude indicator (gyro)
    - altimeter (pitot static)
    - vertical speed indicator (pitot static)
    - heading indicator (gyro)
    - turn coordinator (gyro).
- Determine how faults in one aircraft system, e.g. electrical system can lead to flow-on effects to related systems, e.g. computer systems, hydraulic and pneumatic systems.
- Determine how the relationship between various aircraft systems can be represented using causal loop diagrams.
- Recognise the systems engineering approach to modern aircraft design.
- Comprehend the similarities and differences between the systems of small and slow aircraft and large and fast high-altitude aircraft.
- Symbolise the interdependence of various aircraft systems using systems diagrams.

Topic 5: Aerospace weather systems

- Sketch and classify the composition and structure of the atmosphere.
- Identify and classify basic cloud types, including
  - high-level clouds (cirrus and cirrostratus)
  - mid-level clouds (altocumulus and altostratus)
  - low-level clouds (nimbostratus and stratocumulus).
- Investigate the processes in the formation of clouds, including
  - orographic uplift
  - convectional lifting
  - convergence or frontal lifting
  - radiative cooling.
- Recognise ISA (international standard atmosphere) conditions (temperature 15°C, pressure 1013hPa, humidity 0%, at sea level and environmental lapse rates for temperature minus 2°C per 304.8 metres (1000 ft.) and pressure 1hPa per 9.14 metres (30 ft.)).
- Analyse and interpret synoptic weather charts, including
  - high- and low-pressure systems and the relationship to wind creation
  - pressure identification (isobars)
  - hot and cold fronts, troughs and ridges
  - prediction of wind conditions and pressure.
- Calculate temperature and pressure changes with altitude.
- Comprehend the need for grid-point wind and temperature (GPWT) forecasts.
- Interpret Terminal Area Forecast (TAF) and Meteorological Encoded Terminal Area Report (METAR) reports, including comprehension of
  - location code
  - the calculation of date-time group (Zulu time to local time conversion)
  - wind identification (speed and direction)
  - cloud coverage identification and reporting (overcast complete cloud cover (OVC), broken, cloud cover in 5/8 to 7/8 of sky (BKN), scattered cloud cover in 3/8 to 4/8 of sky (SCT), cloud cover in 1/8 to 2/8 of sky (FEW), no clouds below (CLR), ceiling and visibility okay (CAVOK), and altitude)
  - visibility reporting (0–9999 metres)
  - the relationship between temperature and dew point temperature
  - QNH (barometric pressure above sea level).
- Analyse weather forecasting in relation to aircraft operations.
- Explore space weather forecasting with relation to Earth.

Unit 2: Aerospace technologies

Unit 2 includes learning experiences beyond traditional aircraft to build on students' technology knowledge of contemporary aerospace. These emerging technologies include satellites, space vehicles and remotely piloted aircraft systems (RPAS) and are finding innovative 21st century applications, for example, ways in which aerospace-related technologies can be used to solve problems for people and communities in need. Students develop their knowledge and understanding of the applications of these future-focused and sometimes non-traditional aerospace technologies (or assets) and operations (asset deployment) to solve problems through use of systems thinking habits and systems thinking strategies. In this unit, students engage with real-world problems to develop innovative future-focused solutions.

Unit objectives

1. Recognise and describe problems, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to assets and asset-related operational systems.
2. Symbolise and explain ideas, solutions and relationships in relation to assets and asset-related operational systems.
3. Analyse problems and information in relation to assets and asset-related operational systems.
4. Determine solution success criteria for assets and asset-related operational system problems.
5. Synthesise information and ideas to propose possible assets and asset-related operational systems solutions.
6. Generate assets and asset-related operational systems solutions to provide data to determine the feasibility of proposals.
7. Evaluate and refine ideas and solutions to make justified recommendations.
8. Make decisions about and use mode-appropriate features, language and conventions to communicate development of solutions.

Subject matter

Topic 1: Operational assets

- Identify operations and associated payload types, including passengers (pax), cargo, search and rescue (SAR), disaster relief, surveillance, space exploration, aerial/satellite imagery, satellite weather prediction, and monitoring and data collection.
- Identify, compare and contrast the main asset types based on functionality, including lighter than air, fixed-wing, multi-rotor, rotary-wing, space-based.
- Comprehend the importance of wing and power loading.
- Calculate performance for fixed-wing aircraft using the formulas
  - wing loading = stall speed
    - $wing\ loading = \frac{mass\ of\ aircraft\ (kg)}{wing\ area\ (m^2)}$
  - power loading = performance for small RPAS
    - $power\ loading = \frac{power\ (watts)}{mass\ (kg)}$
- Calculate performance for multi-rotor aircraft using the formulas
  - current draw
    - $I\ (motor\ current)\ = \frac{P\ (motor\ power)}{U\ (battery\ voltage)}$
  - endurance = performance for small RPAS
    - $T\ (time\ in\ hours) = \frac{C\ (battery\ capcity\ in\ amp\ hours)}{I\ (current)}$
- Investigate stability and augmentation systems, including autopilots, accelerometers and gyros, flight modes (manual, stabilised, loiter, autonomous).
- Classify
  - sensors, including optical, thermal, acoustic
  - gimbals, including stabilised, two-axis, three-axis.
- Explore the emerging development of electric flight, including batteries, brushless motors, propellers.
- Examine types of space vehicles, including expendable launch vehicles (ELV), semi-reusable launch vehicles (e.g. space shuttle), reusable launch vehicles, human-rated, satellites, International Space Station (ISS).
- Analyse and critique next-generation launchers, including single stage to orbit (SSTO), e.g. Virgin Galactic.
- Investigate the differences between common rocket engines, e.g. liquid, solid, hybrid, electrical.
- Describe staging of a rocket in terms of payload mass and economics.
- Investigate return-to-earth payload deployment protection methods.
- Comprehend various fail-safe technologies, e.g. return to home, self-destruct, mission abort.
- Brainstorm possible future problem situations in an emerging need area and consider the social, ethical, legal, environmental or economic implications for idea and solution development.
- Determine success criteria to solve a future problem.

Topic 2: Operational environments

- Explain the key geographical and mapping concepts of earth geometry, including latitude, longitude, great circles, prime meridian, poles, equator, declination and Global Navigation Satellite System (GNSS), e.g. GPS concepts and waypoints, speed (knots), magnetic variation.
- Classify the different types of Australian airspace i.e. Class A, C, D, E, and G.
- Investigate operation planning environmental factors, including weather and terrain.
- Recognise equatorial 0°, polar 90°, inclined orbits between 0° and 90°, Geostationary Earth Orbit (GEO), and satellite constellation orbits.
- Compare drag loss to gravity loss ascents to orbits.
- Explain Newton's cannon thought experiment in relation to orbital and escape velocity.
- Explain weightlessness and equilibrium in relation to an orbiting body.

Topic 3: Operational control systems

- Explore the relationship between operational requirements, including data collection and/or analysis and duration and payload, environmental and economic considerations using systems thinking visual frameworks and feedback loop diagrams.
- Describe the different types of control environments, including National Aeronautics and Space Administration (NASA) mission control, RPAS ground control station, air traffic control (ATC).
- Investigate the differences between the human-in-the-loop decision-making in manned and remotely piloted vehicles.
- Represent operational system relationships using systems thinking strategies, i.e. causal loop diagrams.
- Comprehend the role of situational awareness, i.e. monitoring flight variables through the scanning of systems and the environment.
- Use systems thinking habits and systems thinking strategies in regards to operational planning, including
  - assess the areas of likely failure and discuss how to mitigate against these
  - recognise and describe the long-term impacts versus short-term gains
  - consider the likelihood of success or failure/loss and propose an outcome based on operation variables
  - generate an operations strategy/plan
  - payload deployment considerations.

Topic 4: Future applications

- Investigate current aerospace activities that use non-traditional aerospace technologies, e.g. air taxi, RPAS used in agriculture, property surveillance, SAR, emergency services.
- Explore everyday applications for non-traditional aerospace technologies and analyse market potential, e.g. hazardous inspections, delivery systems, ecological inspections, power grid monitoring, surf lifesaving (shark spotting, surf conditions).
- Identify and describe potential ethical and safety issues concerning the application of non-traditional aerospace technologies.
- Explore current space technologies and investigate possible and probable developments for everyday applications, e.g. flying cars, jet packs and other forms of personal transportation devices.
- Investigate future Earth and space exploration, transportation and research, e.g. high-altitude sub-orbital flight, future manned Moon and Mars missions.
- Use the problem-solving process in Aerospace Systems to solve an identified future problem, e.g. traffic congestion, personal safety or security, delivery systems, including
  - exploration of the problem
    - recognise and describe characteristics of the problem in relation to related aerospace systems, subsystems and system components
    - symbolise the incorporated aerospace systems with visual frameworks, feedback loops, flow charts, diagrams, sketches or pictures
    - research and investigate similar situations to understand the nature of the problem
    - analyse contributing factors and areas of weakness to identify the elements, components, features and structure of the problem
    - describe causes and effects using causal and feedback loops
    - determine solution success criteria considering the elements, components, features and structure of the problem
  - development of ideas
    - investigate historic solutions and analyse positive and negative consequences
    - research and investigate the application of potential future aerospace and related technologies
    - symbolise and explain synthesis of ideas using visual frameworks, feedback loops, flow charts, diagrams, sketches and/or pictures with appropriate annotations
    - evaluate various ideas in relation to solution success criteria
    - communicate the relationship between various ideas and solution success criteria, e.g. plus, minus, interesting (PMI) charts
    - propose possible short- and long-term outcomes
    - propose a solution

- generation of the solution
  - generate the proposed solution for testing
  - test, simulate or hypothetically apply the proposed solution in the original problem situation to provide data
  - refine the solution to match with solution success criteria
  - communicate the solution to a specified audience using oral, written or visual modes
  - implement by producing, simulating or hypothetically applying the solution in the original problem situation to provide data
- evaluation and refinement
  - evaluate the solution and its impact on related systems and system components using the solution success criteria
  - assess whether the solution is short- or long-term
  - recommend and justify future modifications or enhancements.

Unit 3: Aerospace ecosystems

In Unit 3, students will study the ecosystems used in the commercially competitive air transportation industry. The unit topics provide a focus for student learning, and problem-solving engages students in the development of practical solutions to actual, possible or probable operational problems. Students use systems thinking habits and systems thinking strategies, including visual frameworks and causal loop diagrams to explore and document the relationships between and within aerospace ecosystems. Real-world situations, case studies and simulations are used to support student learning.

Learning in this unit equips students with an appreciation for the role that aerospace ecosystems and their interconnectivity play in promoting public confidence in a highly competitive and safety-conscious industry.

Unit objectives

1. Recognise and describe problems, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to operational systems.
2. Symbolise and explain ideas, solutions and relationships in relation to operational systems.
3. Analyse problems and information in relation to operational systems.
4. Determine solution success criteria for operational systems problems.
5. Synthesise information and ideas to propose possible operational systems solutions.
6. Generate operational systems solutions to provide data to determine the feasibility of proposals.
7. Evaluate and refine ideas and solutions to make justified recommendations.
8. Make decisions about and use mode-appropriate features, language and conventions to communicate development of solutions.

Subject matter

Topic 1: Aerospace regulatory systems

- Comprehend the need for a global approach to aerospace operations and safety in a growing and connected world, including
  - aviation rules, including rules of the air, air traffic procedures and runway markings
  - aircraft maintenance standards
  - security, customs and quarantine
  - common language and communication protocols
  - navigation safety (charts, maps and meteorology).
- Recognise the significance of the Chicago Convention; the creation of the International Civil Aviation Organisation (ICAO) and its governance; its leadership role in areas; and that safety is at the core of ICAO's fundamental objectives.
- Determine the influence of ICAO on the Civil Aviation Safety Authority (CASA).
- Identify and explain the functions of CASA.
- Explain the impact the Bureau of Meteorology has on the aviation industry.
- Recognise and critique the role of the International Air Transport Association (IATA).
- Brainstorm problem scenarios collaboratively (in small groups) in relation to the absence of accepted worldwide aviation regulations, and propose a range of ideas for solving the identified problems.

Topic 2: Human performance

- Use the problem-solving process to solve an identified real-world human performance problem.
- Investigate the effects of health and fitness on human performance in an aerospace environment, including
  - body mass index (BMI) and diet
  - hydration
  - smoking
  - general and emotional health.
- Explore vision issues in aerospace and the effects on human performance, including
  - binocular vision
  - empty field myopia
  - effects of low oxygen
  - scanning
  - illusions and perception.

- Comprehend the causes of disorientation that may be felt due to the three sensing mechanisms
  - eyes
  - inner ear
  - skeletal muscles and joints.
- Explain the effect of G force on the human body.
- Comprehend the effects of alcohol and drugs on human performance.
- Examine the effects of noise on human performance and the importance of the ear in relation to balance and orientation.

Topic 3: Safety management systems and human factors

- Comprehend that a 'culture of safety' is vital to the aerospace industry, and recognise
  - its context in aviation
  - the evolution of safety, including technical, human and organisational factors.
- Recognise that technical reliability is a major endeavour of the industry.
- Analyse the SHELL model to represent the main components of human factors, i.e.
  - software (S) — the rules, procedures and written documents that are part of the standard operating procedures
  - hardware (H) — the air traffic control suites, configuration, controls and surfaces, displays and functional systems
  - environment (E) — the situation in which the LHS system must function; the social, economic and natural environments
  - liveware (L) — the human beings involved in the system, including the controller with other controllers, flight crews, engineers and maintenance people, management and administration people and human performance, capabilities and limitations.
- Investigate a human error accident by applying the SHELL model.
- Investigate the role of safety in high-consequence industries, e.g. nuclear, oil and gas exploration, to reinforce the need for aviation to take a systems approach to the maintenance of safety standards.
- Identify general safety hazards in the aerospace industry using the categories of weather, technical failures, human failures and organisational failures.
- Comprehend the relevance of James Reason's (1997) 'Swiss cheese model' to explain the reasons for organisational accidents, including the concepts of active failures and latent conditions.
- Explore the elements of a safety management system, including
  - safety policy and objectives
  - safety risk management
  - safety assurance
  - safety promotion with both the aviation safety regulator and all operators requiring a documented system to be in place
  - human factors.

- Explain and use the risk management process of
  - hazard identification
  - risk analysis probability and severity
  - risk assessment and tolerability
  - risk control and mitigation.
- Describe the importance of emergency response planning in aviation.
- Identify and solve a safety management problem associated with landside or airside operations at a busy international airport, e.g. Dubai, Heathrow.

Topic 4: Operational accident and incident investigation processes

- Identify and explain the functions of the Australian Transport Safety Bureau (ATSB).
- Comprehend the aviation accident and incident investigation process, including
  - the objectives of an investigation
  - accident site coordination and security
  - hazards at accident sites
  - protection of the aircraft wreckage and associated evidence
  - custody and removal of evidence into secure storage.
- Explain the organisation and conduct of an investigation, including the purpose of the preliminary and final reports.
- Comprehend an ATSB final report of a major aviation accident.
- Conduct an investigation into a recent school or local community accident or incident and represent the identified causal chain using a causal loop diagram.

Topic 5: Airport and airline operation systems

- Recognise how airlines approach air travel as a business, including their structure, marketing, and passenger yield management strategies, including calculations involving
  - available seat kilometres (ASK)
  - revenue passenger kilometres (RPK)
  - passenger load factor (PLF) (see load factor)
  - cost for available seat kilometres (CASK)
  - revenue available seat kilometres (RASK)
  - passenger revenue per available seat kilometre (PRASK)
  - passenger yield (PY).
- Comprehend that scheduled and on-occurrence maintenance and inspections ensure that passengers fly safely.
- Define and explain how the industry is classified into general groupings of international, domestic and regional airlines.
- Identify the difference between full-service, hybrid/new-world, and low-cost carriers.
- Explore the factors that lead to route and aircraft selection, including 'hub-and-spoke' as opposed to 'point-to-point' network design models.
- Comprehend airport design considerations, including
  - location
  - runway design
  - taxiway and tarmac design
  - terminal design
  - environmental
  - accessibility
  - security
  - ground support services
  - other infrastructure.
- Comprehend that the breadth of the airport business is expanding with major revenue streams in addition to aeronautical revenue, including
  - landside transport revenue, e.g. car parking and car rental
  - retail revenue, e.g. leasing retail space
  - airport terminal revenue, e.g. aircraft parking, passenger transit fees
  - other commercial activities.
- Solve a problem associated with an unprofitable airline route or aircraft using systems thinking habits and systems thinking strategies, including maintenance costs, the travelling public on the route, flight, ground and human resources costs.

Unit 4: Aircraft performance systems and human factors

In Unit 4, students study aircraft performance systems and human factors to understand the issues that impact on their operation in aerospace contexts. Unit topics provide an instructional focus for problem-solving experiences that promote students' understanding of the necessity for continual development of aircraft systems technologies. Students use systems thinking habits and systems thinking strategies to explore aircraft operational systems in order to solve actual, possible or probable problems. Through their study of this unit, students develop an understanding of the interdependencies that exist between and within the various systems that function to maintain the safe and efficient operation of innovative contemporary aircraft.

Learning in this unit equips students with an appreciation for the role that applied aerospace technologies play in the promotion of public confidence in a highly competitive and safety-conscious industry.

Unit objectives

1. Recognise and describe problems, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aircraft performance systems and human factors.
2. Symbolise and explain ideas, solutions and relationships in relation to aircraft performance systems and human factors.
3. Analyse problems and information in relation to aircraft performance systems and human factors.
4. Determine solution success criteria for aircraft performance systems and human factors problems.
5. Synthesise information and ideas to propose possible aircraft performance systems and human factors solutions.
6. Generate aircraft performance systems and human factors solutions to provide data to determine the feasibility of proposals.
7. Evaluate and refine ideas and solutions to make justified recommendations.
8. Make decisions about and use mode-appropriate features, language and conventions to communicate development of solutions.

Subject matter

Topic 1: Airspace management

- Use the problem-solving process to solve an identified real-world airspace management problem.
- Identify and explain the functions of Airservices Australia.
- Investigate air traffic principles, including air traffic control, air traffic separation, flight information regions, air traffic advisory services, flight information services and alerting services.
- Recognise a time zone as being a region in which the same standard time is used and that local time in a time zone is defined by its offset (difference) from Coordinated Universal Time (UTC), the world's time standard.
- Recognise the three aviation emergency phases used by ATC (uncertainty, alert and distress) and how they relate to the urgency of a situation.
- Identify and explain flight rules and procedures with respect to: classification of airspace; Visual Flight Rules (VFR) versus Instrument Flight Rules (IFR); separation standards; meteorology, including Visual Meteorological Conditions (VMC); and Instrument Meteorological Conditions (IMC).
- Explain the requirements for flight plans, including principles (i.e. aircraft type and characteristics, the flight of the aircraft, the flight rules in use and on-board equipment); completing; and lodging.
- Recognise and use aeronautical communications, including
  - the phonetic alphabet
  - the basic structure of a radio call, including who you are calling, who you are, where you are and what your intentions are.
- Comprehend the need for aeronautical information services, including Airservices Australia charts and publications.
- Investigate relevant case studies and propose solutions to identified airspace management problems.
- Communicate air traffic control systems that contribute to safe and efficient airspace management using causal and/or feedback loop diagrams.

Topic 2: Aircraft performance

- Describe and explain the function, limitations and data output of the six key flight instruments
  - airspeed indicator (pitot static)
  - attitude indicator (gyro)
  - altimeter (pitot static)
  - vertical speed indicator (pitot static)
  - heading indicator (gyro)
  - turn coordinator (gyro).
- Interpret the information from the six key flight instruments to make decisions in real-world situations.
- Define and explain airspeed limitations of
  - normal operating speed (Vno)
  - never exceed speed (Vne)
  - maximum manoeuvring speed (Va)
  - turbulence penetration speed (Vb)
  - flap operating speed (Vfo)
  - flap extension speed (Vfe)
  - stall speed (Vs) in clean (Vs1) and landing configuration (Vs0).
- Examine turbine engines and investigate the differences between turbofan, turbojet and turboprop engines and analyse their individual advantages and limitations.
- Investigate the environmental impacts of operating jet engines, including noise, local air quality and emissions.
- Investigate the effect of altitude on piston and turbine engine performance.
- Calculate pressure and density altitude using the formulas

  $$pressure\ altitude = airfield\ elevation + (ISA\ pressure - QNH) \times 30$$

  $$density\ altitude = pressure\ altitude + [120 \times (OAT - ISA\ Temp)]$$

  $$OAT = outside\ air\ temperature\ in\ ℃$$

  $$ISA\ temperature = 15℃ - 1.98℃\ per\ 1000ft.(304.8\ metres)$$

  $$ISA\ pressure = 1013\ hPa\ @\ sea\ level - 1\ hPa\ per\ 30ft$$

- Determine flight performance parameters using take-off, landing and loading charts.
- Brainstorm possible or probable aircraft problem situations and consider the consequences given the array of aircraft safety systems designed to negate aircraft flight failure.

Topic 3: Aircraft maintenance

- Explore the relationships between aircraft maintenance requirements, including data collection and analysis of economic and safety considerations, using systems thinking visual frameworks and feedback loop diagrams.
- Examine the operation of
  - basic aircraft electrical systems
  - hydraulic systems
  - pressurisation systems
  - fuel and de-icing systems.
- Define and explain the purpose of
  - light or line maintenance, e.g. pre-flight checks, daily checks (before first flight), fluids, failure rectification as well as minor, scheduled maintenance tasks
  - base or heavy maintenance — tasks that are generally more in-depth and take longer than light or line maintenance tasks, but are performed less frequently
  - shop or component maintenance — maintenance on components when removed from aircraft, e.g. engines, APU, seats.
- Identify and describe potential safety issues with maintenance interval compliance.

Topic 4: Aircraft navigation and radio communication technologies

- Interpret aeronautical charts, including World Aeronautical Chart (WAC), Visual Navigation Chart (VNC), and Visual Terminal Chart (VTC); students will
  - use plotter (or ruler and protractor) to find distance and bearing
  - convert true bearing to a magnetic bearing
  - identify ground height to calculate minimum safe altitude (1000 ft. above the highest obstacle within 10 nm either side of flight planned track during night VFR and IFR flight)
  - apply the hemispheric rule (odds and evens) for altitude selection
  - recognise airspace boundaries.
- Interpret *En Route Supplement Australia* (ERSA), including to
  - access runway direction, slope, elevation and length information
  - comprehend local airfield information, including facilities and dangers
  - identify location of key infrastructure, e.g. terminals and windsocks
  - identify PRD: prohibited, restricted, danger area information.
- Interpret grid-point wind and temperature (GPWT) forecast to obtain wind speed and direction at various heights.
- Calculate crosswind, head/tail wind, drift/crab angle, heading to steer, speed/distance/time and fuel using a flight computer.

- Comprehend CASA regulatory requirements for maintaining a fuel reserve.
- Tabulate calculated data into a flight plan using the CASA flight plan format (SP107).
- Calculate a track error, track made good, closing angle, track change required and track to intercept using a flight computer or the 1 in 60 rule.
- Calculate any changes in estimated time of arrival (ETA), estimated time en route (ETE), ground speed and fuel information due to unplanned events.
- Use systems thinking habits and systems thinking strategies and problem-solving to determine alternative solutions to a given navigation problem, e.g. fog at a destination airport or aircraft engine or instrument failure.
- Describe electronic flight information systems (EFIS), head-up display (HUD) and glass cockpit.
- Analyse the presentation of information on EFIS and HUD and determine the advantages and disadvantages of each in terms of aircraft operations.
- Define and explain the operation and limitations of
  - primary surveillance radars (PSR)
  - secondary surveillance radars (SSR)
  - visual approach slope guidance systems (T-VASIS, VASIS, PAPI)
  - instrument landing systems (ILS)
  - automatic dependent surveillance-broadcast (ADS-B)
  - traffic collision avoidance systems (TCAS)
  - global navigation satellite systems, including Global Positioning System (GPS), and Gallileo system.
- Generate solutions to a cockpit-related instrumentation failure by analysing using systems thinking visual frameworks and feedback loops during the problem-solving process in Aerospace Systems.

Topic 5: Human performance and limitations

- Describe and explain the causes, symptoms and remedies of hypoxia and hyperventilation.
- Explore the role of human decision-making, personality and attitudes in aerospace situations.
- Examine the relationships between human error, human behaviour, sleep, stress and fatigue.
- Investigate the importance of cockpit design, including ergonomics, standardisation, cognitive load reduction, and information interpretation, with regard to electronic flight information systems (EFIS) and head-up display (HUD).
- Comprehend the importance of effective crew resource management, including
  - language
  - culture
  - environment
  - leadership
  - communication
  - leadership versus authority.
- Explain the factors affecting situation awareness, including
  - automation and system design — automatic systems need to be actively monitored, along with flight instruments and controls; failure to do so reduces the operator's situational awareness; ergonomics requires information to be presented in a user-friendly way; improving situational awareness
  - stress, workload and training — stress affects people's abilities to process information; in high-stress and high-workload situations, people are not able to process as much information and therefore situational awareness suffers; current training supports automatic execution of the correct actions when real-life emergency situations occur.
  - physiological factors and preconceptions — factors such as illness and medication can have a drastic effect on information processing and therefore on situational awareness; a preconception about what is going to happen reduces situational awareness and can lead to incorrect and potentially harmful actions
- Identify and solve a problem associated with the relationship between human and aircraft systems given the physiological effects of flight stress, using the problem-solving process in Aerospace Systems.

Assessment

Internal assessment 1: Aerospace solution (25%)

Students document the application of a problem-solving process in response to an identified real-world aerospace problem. The response is a coherent work that includes written paragraphs and annotations, diagrams, sketches, drawings, photographs, tables, spreadsheets and prototypes.

Assessment objectives

2. Symbolise and explain ideas, a solution and relationships in relation to aerospace management, safety, and airline and/or airport operations.
4. Determine solution success criteria for the operational systems problem.
5. Synthesise information and ideas to propose a possible aerospace management, safety, and airline and/or airport operations solution.
6. Generate an aerospace management, safety, and airline and/or airport operations solution to provide data to determine the feasibility of the proposal.
7. Evaluate and refine ideas and a solution to make justified recommendations.
8. Make decisions about and use mode-appropriate features, language and conventions to communicate development of the solution.

Specifications

This task requires students to:

- symbolise and explain the incorporated aerospace systems, the development of ideas and the solution with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures
- determine a solution success criteria considering the identified elements, components and features, and their relationship to the structure of the aerospace operational systems problem
- synthesise aerospace systems, technology, and research information, and ideas to propose a possible solution to the aerospace operational systems problem
- generate the proposed solution for the aerospace operational systems problem, and testing, simulating or hypothesising to provide data (e.g. pictures, tables, surveys, interview recordings, audio-visual recording) for evaluation including (if applicable) annotated photographs or screen captures of the solution prior to and after testing, simulating or hypothesising
- evaluate and refine ideas and the solution for the aerospace operational systems problem in relation to solution success criteria
- recommend and justify future modifications or enhancements to ideas and the solution to the aerospace operational systems problem
- communicate the development of ideas and the solution for the aerospace operational systems problem using written and visual features, e.g. PMI (plus, minus, interesting) charts, tables, pictures, bubble diagrams, feedback loops
- communicate data using diagrams, tables and/or spreadsheets.

It is recommended that this task is designed so that students can develop a response in approximately 10 hours of class time.

Stimulus specifications

The teacher provides an appropriate aerospace operational systems problem, for example:

- investigate why the current location of an airport has created a concern for local communities and propose a solution to the identified cause/s
- investigate an aircraft accident or incident and propose a solution to the identified cause/s
- propose an equitable solution for an airline that is experiencing a financial loss on several of its routes.

Conditions

- Students can develop their responses in class time and their own time.
- This is an individual task.

Response requirements

Written and visual (including images, graphs, calculations and diagrams): up to 10 A4 pages, up to 2000 words

Mark allocation

Criterion	Assessment objectives	Marks
Symbolising and Communicating	2, 8	7
Determining and Generating	4, 6	9
Synthesising and Evaluating	5, 7	9
	Total marks:	25

Instrument-specific marking guide

Symbolising and Communicating	Marks
The student response has the following characteristics:	
• adept symbolisation and discerning explanation of ideas, a solution and relationships in relation to aerospace management, safety, and airline and/or airport operations with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures • astute decision-making about, and proficient use of – written and visual features to communicate about a solution – language for a technical audience – grammatically accurate language structures – referencing conventions	6–7
• effective symbolisation and considered explanation of ideas, a solution and relationships in relation to aerospace management, safety, and airline and/or airport operations with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures • effective decision-making about, and fluent use of – written and visual features to communicate about a solution – language for a technical audience – grammatically accurate language structures – referencing conventions	4–5
• competent symbolisation and appropriate explanation of some ideas, a solution and relationships in relation to aerospace management, safety, and airline and/or airport operations with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures • appropriate decision-making about, and use of – written and visual features to communicate about a solution – suitable language – grammatically accurate language structures – referencing conventions	2–3
• inconsistent symbolisation or superficial explanation of aspects of ideas, a solution, or relationships in relation to aerospace management, safety, and airline and/or airport operations • inconsistent decision-making about, and inconsistent use of – written and visual features – suitable language – grammar and language structures – folio or referencing conventions.	1
The student response does not match any of the descriptors above.	0

Determining and Generating	Marks
The student response has the following characteristics:	
• astute determination of essential solution success criteria for the operational systems problem • coherent generation of a solution, including − aerospace management − safety − airline and/or airport operations • provide valid data to effectively determine the feasibility of a solution	8–9
• reasoned determination of effective solution success criteria for the operational systems problem • effective generation of a solution, including − aerospace management − safety − airline and/or airport operations • provide valid data to effectively determine the feasibility of a proposal	6–7
• logical determination of appropriate solution success criteria for the operational systems problem • adequate generation of a solution, including − aerospace management − safety − airline and/or airport operations • provide relevant data to determine the feasibility of a proposal	4–5
• reasonable determination of some solution success criteria for the operational systems problem • partial generation of a solution, including − aerospace management − safety − airline and/or airport operations • provide elements of data to partially determine the feasibility of a proposal	2–3
• statements about some success criteria for the operational systems problem • generation of elements of a solution.	1
The student response does not match any of the descriptors above.	0

Synthesising and Evaluating	Marks
The student response has the following characteristics:	
• coherent and logical synthesis of relevant aerospace systems, technology and research information, and ideas to propose a possible solution, including – aerospace management – safety – airline and/or airport operations solution • critical evaluation of ideas and a solution using success criteria • discerning refinement of ideas and a solution to make astute recommendations justified by data and research evidence	8–9
• logical synthesis of relevant aerospace systems, technology and research information, and ideas to propose a possible solution, including – aerospace management – safety – airline and/or airport operations solution • reasoned evaluation of ideas and a solution using success criteria • effective refinement of ideas and a solution to make considered recommendations justified by data and research evidence	6–7
• simple synthesis of aerospace systems, technology, and research information and ideas to propose a possible solution, including – aerospace management – safety – airline and/or airport operations solution • feasible evaluation of ideas and a solution using success criteria • adequate refinement of ideas and a solution to make fundamental recommendations justified by data and research evidence	4–5
• rudimentary synthesis of partial aerospace systems, technology, or research information and/or ideas to propose a possible solution, including – aerospace management – safety – airline and/or airport operations solution • superficial evaluation of ideas or a solution using some success criteria to make elementary recommendations	2–3
• unclear combinations of information or ideas • identification of a change about an idea or the solution.	1
The student response does not match any of the descriptors above.	0

Internal assessment 2: Examination — combination response (25%)

Assessment objectives

1. Recognise and describe problems, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aerospace operational systems.
2. Symbolise and explain ideas, solutions and relationships in relation to aerospace operational systems.
3. Analyse problems and information in relation to aerospace operational systems.
5. Synthesise information and ideas to propose possible aerospace operational systems solutions.
7. Evaluate and refine ideas and solutions to make justified recommendations.

Specifications

The teacher provides an examination that includes:

- questions that may ask students to
  - respond using multiple choice, single words or sentences
  - sketch or draw graphs, tables and diagrams
  - calculate using concepts and principles from Unit 3 Topic 5 subject matter
  - respond to seen or unseen stimulus materials
- a balance of questions across the assessment objectives
- instructions to write in full sentences where required.

Question specifications

The examination must be aligned to the specifications provided in the table below.

Focus of question	Mark allocation (± 2%)	Objectives	In these questions, students:
Simple familiar	60%	Typically, these questions focus on Objectives 1, 3 and 5, and can provide evidence of Objective 2.	respond to situations where: • relationships and interactions are obvious and have few elements • the required procedure is – clear from the way the question is posed – in a context that has been a focus of prior learning
Complex familiar	20%	These questions can focus on any of the objectives.	respond to situations where: • relationships and interactions have a number of elements and connections are made with knowledge, concepts and principles in relation to aerospace operational systems • the required procedure is – clear from the way the question is posed – in a context that has been a focus of prior learning
Complex unfamiliar	20%	Typically, these questions focus on Objectives 3, 5 and 7.	choose and apply appropriate procedures in a situation where: • relationships and interactions have a number of elements and connections are made with knowledge, concepts and principles in relation to aerospace operational systems • the required procedure is – not clear from the way the question is posed – in a context in which students have had limited prior experience.

Stimulus specifications

- The teacher provides stimulus that when unseen
  - must not be copied from information or texts that students have previously been exposed to or have used directly in class
  - is succinct enough to allow students sufficient time to engage with them.
- The teacher provides stimulus that when seen (due to its length, complexity or volume of data) is shared with students prior to the administration of the assessment instrument.

Conditions

- This is an individual supervised task.
- Time allowed
  - Perusal time: 5 minutes
  - Working time: 120 minutes
- The teacher must provide the QCAA Aerospace Systems formula sheet.
- Students may use
  - a non-programmable scientific calculator
  - a QCAA-approved analog slide rule type and aviation plotter or protractor and ruler.
- Students must not bring notes into the examination.

Mark allocation

Criterion	Assessment objectives	Marks
Aerospace systems knowledge and problem-solving	1, 2, 3, 5, 7	25
	Total marks:	25

Instrument-specific marking guide

Aerospace systems knowledge and problem-solving	Cut-off	Marks
The student response has the following characteristics:		
• across the full range of simple familiar, complex familiar and complex unfamiliar situations – accurate and discriminating recognition and discerning description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; adept symbolisation and discerning explanation of ideas, solutions and relationships; insightful and accurate analysis of problems and information; coherent and logical synthesis of information and ideas to propose possible solutions; critical evaluation and discerning refinement of ideas and solutions to make astutely justified recommendations	> 96%	25
	> 93%	24
• in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations – accurate and discriminating recognition and discerning description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; adept symbolisation and discerning explanation of ideas, solutions and relationships; insightful and accurate analysis of problems and information; coherent and logical synthesis of information and ideas to propose possible solutions; critical evaluation and discerning refinement of ideas and solutions to make astutely justified recommendations	> 89%	23
	> 86%	22

Aerospace systems knowledge and problem-solving	Cut-off	Marks
• in a comprehensive range of simple familiar situations, and in complex familiar and complex unfamiliar situations – accurate recognition and effective description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; methodical symbolisation and effective explanation of ideas, solutions and relationships; considered analysis of problems and information; logical synthesis of information and ideas to propose possible solutions; reasoned evaluation and effective refinement of ideas and solutions to make considered recommendations	> 82%	21
	> 78%	20
• in a range of simple familiar situations, and in complex familiar and complex unfamiliar situations – accurate recognition and effective description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; methodical symbolisation and effective explanation of ideas and solutions; considered analysis of problems and information; logical synthesis of information and ideas to propose possible solutions; reasoned evaluation and effective refinement of ideas and solutions to make considered recommendations	> 75%	19
	> 71%	18
• in a range of simple familiar situations and in complex familiar situations – appropriate recognition and description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; competent symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to propose possible solutions; feasible evaluation and adequate refinement of ideas and solutions to make fundamental recommendations	> 68%	17
	> 64%	16
• in a range of simple familiar situations and in some complex familiar situations – appropriate recognition and description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; competent symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to propose possible solutions; feasible evaluation and adequate refinement of ideas and solutions to make fundamental recommendations	> 60%	15
	> 57%	14
• in simple familiar situations – appropriate recognition and description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; variable symbolisation and appropriate explanation of ideas and solutions; appropriate analysis of problems and information; simple synthesis of information and ideas to propose possible solutions; feasible evaluation and adequate refinement of ideas and solutions to make fundamental recommendations	> 53%	13
	> 50%	12

Aerospace systems knowledge and problem-solving	Cut-off	Marks
• in simple familiar situations – variable recognition and superficial description of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; variable symbolisation and superficial explanation of ideas and solutions; superficial analysis of problems and information; rudimentary synthesis of information and ideas to propose possible solutions; superficial evaluation and adequate refinement of ideas and solutions to make elementary recommendations	> 46%	11
	> 42%	10
• in some simple familiar situations – variable recognition and superficial description of aspects of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; superficial explanation of ideas and solutions; superficial analysis of problems and information; rudimentary synthesis of information and ideas to propose partial possible solutions; superficial evaluation of ideas and solutions to make elementary recommendations	> 37%	9
	> 33%	8

Aerospace systems knowledge and problem-solving	Cut-off	Marks
• in a limited range of simple familiar situations – variable recognition and superficial description of aspects of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; superficial explanation of ideas and solutions; superficial analysis of aspects of problems and information; unclear combination of information and ideas; superficial evaluation of ideas and solutions	> 28%	7
	> 24%	6
• disjointed recognition and statements about aspects of aerospace operational systems problems, knowledge, concepts and principles, and systems thinking habits and systems thinking strategies; identification of a change about ideas, solutions and information; unclear combination of information and ideas	> 19%	5
	> 14%	4
• statements about aspects of aerospace operational systems problems, knowledge, concepts and principles; statements about ideas, solutions and information; isolated and unclear combination of information and ideas	> 10%	3
	> 5%	2
• isolated and unclear statements about aspects of aerospace operational systems problems, knowledge, concepts and principles.	> 0%	1
The student response does not match any of the descriptors above.		0

Internal assessment 3: Aerospace solution (25%)

Students document the application of a problem-solving process in response to an identified real-world aerospace problem. The response is a coherent work that includes written paragraphs and annotations, diagrams, sketches, drawings, photographs, tables, spreadsheets and prototypes.

Assessment objectives

2. Symbolise and explain ideas, a solution and relationships in relation to aircraft performance systems and human factors.
4. Determine solution success criteria for the aircraft performance systems and/or human factors problem.
5. Synthesise information and ideas to propose a possible aircraft performance systems and/or human factors solution.
6. Generate an aircraft performance systems and/or human factors solution to provide data to determine the feasibility of the proposal.
7. Evaluate and refine ideas and a solution to make justified recommendations.
8. Make decisions about and use mode-appropriate features, language and conventions to communicate development of the solution.

Specifications

This task requires students to:

- symbolise and explain the incorporated aerospace systems, the development of ideas and the solution with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures
- determine solution success criteria considering the identified elements, components and features, and their relationship to the structure of the aircraft performance systems and/or human factors problem
- synthesise aerospace systems, technology, and research information, and ideas to propose a possible solution to the aircraft performance systems and/or human factors problem
- generate the proposed solution for the aircraft performance systems and/or human factors problem and testing, simulating or hypothesising to provide data (e.g. pictures, tables, surveys, interview recordings, audio-visual recording) for evaluation including (if applicable), annotated photographs or screen captures of the solution prior to and after testing, simulating or hypothesising
- evaluate and refine ideas and the solution for the aircraft performance systems and/or human factors problem in relation to solution success criteria
- recommend and justify future modifications or enhancements to ideas and the solution to the aircraft performance systems and/or human factors problem
- communicate the development of ideas and the solution for an aircraft performance systems and/or human factors problem using written and visual features, e.g. PMI (plus, minus, interesting) charts, tables, pictures, bubble diagrams, feedback loops
- communicate data using diagrams, tables and/or spreadsheets.

It is recommended that this task is designed so that students can develop a response in approximately 10 hours of class time.

Stimulus specifications

The teacher provides an appropriate aircraft performance systems and/or human factors problem context, for example:

- modifying aircraft cockpit design to support greater pilot situational awareness during unusually stressful operational circumstances
- planning a multi-stage flight with diversions, taking into account altitude density, airspace, take-off and landing performance tasks and weather
- investigating a case study of an aircraft accident associated with human factors to develop an education program (e.g. in a multimedia format) to provide to an aerospace industry stakeholder.

Conditions

- Students can develop their responses in class time and their own time.
- This is an individual task.

Response requirements

Written and visual (including images, graphs, calculations and diagrams): up to 10 A4 pages, up to 2000 words

Mark allocation

Criterion	Assessment objectives	Marks
Symbolising and Communicating	2, 8	7
Determining and Generating	4, 6	9
Synthesising and Evaluating	5, 7	9
	Total marks:	25

Instrument-specific marking guide

Symbolising and Communicating	Marks
The student response has the following characteristics:	
• adept symbolisation and discerning explanation of ideas, a solution and relationships in relation to aircraft performance systems and human factors with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures • astute decision-making about, and proficient use of – written and visual features to communicate about a solution – language for a technical audience – grammatically accurate language structures – referencing conventions	6–7
• effective symbolisation and considered explanation of ideas, a solution and relationships in relation to aircraft performance systems and human factors with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures • effective decision-making about, and fluent use of – written and visual features to communicate about a solution – language for a technical audience – grammatically accurate language structures – referencing conventions	4–5
• competent symbolisation and appropriate explanation of some ideas, a solution and relationships in relation to aircraft performance systems and human factors with visual frameworks, causal and feedback loops, flow charts, diagrams, sketches and/or pictures • appropriate decision-making about, and use of – written and visual features to communicate about a solution – suitable language – grammatically accurate language structures – referencing conventions	2–3
• inconsistent symbolisation or superficial explanation of aspects of ideas, a solution or relationships in relation to aircraft performance systems and human factors • inconsistent decision-making about, and inconsistent use of – written and visual features – suitable language – grammar and language structures – folio or referencing conventions.	1
The student response does not match any of the descriptors above.	0

Determining and Generating	Marks
The student response has the following characteristics:	
• astute determination of essential solution success criteria for the aircraft performance systems and/or human factors problem • purposeful generation of a solution, including – aircraft performance systems and/or human factors • provide valid data to critically determine the feasibility of a solution	8–9
• reasoned determination of effective solution success criteria for the aircraft performance systems and/or human factors problem • effective generation of a solution, including – aircraft performance systems and/or human factors • provide valid data to effectively determine the feasibility of a proposal	6–7
• logical determination of appropriate solution success criteria for the aircraft performance systems and/or human factors problem • adequate generation of a solution, including – aircraft performance systems and/or human factors • to provide relevant data to determine the feasibility of a proposal	4–5
• reasonable determination of some solution success criteria for the aircraft performance systems and/or human factors problem • partial generation of a solution, including – aircraft performance systems and/or human factors • elements of data to partially determine the feasibility of a proposal	2–3
• statements about some solution success criteria for the aircraft performance systems and/or human factors problem • generation of elements of an aircraft performance systems and/or human factors solution.	1
The student response does not match any of the descriptors above.	0

Synthesising and Evaluating	Marks
The student response has the following characteristics:	
• coherent and logical synthesis of relevant aerospace systems, technology, and research information and ideas to propose a possible solution, including – aircraft performance systems and/or human factors • critical evaluation of ideas and a solution using success criteria • discerning refinement of ideas and a solution using success criteria to make astute recommendations justified by data and research evidence	8–9
• logical synthesis of relevant aerospace systems, technology, and research information and ideas to propose a possible solution, including – aircraft performance systems and/or human factors • reasoned evaluation of ideas and a solution using success criteria • effective refinement of ideas and a solution using success criteria to make considered recommendations justified by data and research evidence	6–7
• simple synthesis of aerospace systems, technology, and research information and ideas to propose a solution, including – aircraft performance systems and/or human factors • feasible evaluation of ideas and a solution using success criteria • adequate refinement of ideas and a solution using some success criteria to make fundamental recommendations justified by data and research evidence	4–5
• rudimentary synthesis of partial aerospace systems, technology, or research information and/or ideas to propose an aircraft performance systems and/or human factors solution • superficial evaluation of ideas or a solution using some success criteria to make elementary recommendations	2–3
• unclear combinations of information or ideas • identification of a change about an idea or the solution.	1
The student response does not match any of the descriptors above.	0

External assessment: Examination — combination response (25%)

External assessment is developed and marked by the QCAA. The external assessment in Aerospace Systems is common to all schools and administered under the same conditions, at the same time, on the same day.

Assessment objectives

1. Recognise and describe problems, aerospace technology knowledge, concepts and principles, and systems thinking habits and systems thinking strategies in relation to aircraft performance systems and human factors.
2. Symbolise and explain ideas, solutions and relationships in relation to aircraft performance systems and human factors.
3. Analyse problems and information in relation to aircraft performance systems and human factors.
5. Synthesise information and ideas to propose possible aircraft performance systems and human factors solutions.
7. Evaluate and refine ideas and solutions to make justified recommendations.

Specifications

This examination:

- consists of a number of different types of questions relating to Unit 4
- may ask students to respond using
  - multiple choice
  - single words
  - sentences or paragraphs
- may ask students to
  - sketch, draw, graph, create tables and/or diagrams
  - calculate using formulas drawn from across Unit 4 subject matter
  - interpret unseen stimulus materials.

Question specifications

The examination will be aligned to the specifications provided in the table below.

Focus of question	Mark allocation (± 2%)	Objective	In these questions, students:
Simple familiar	60%	Typically, these questions focus on Objectives 1, 3 and 5, and can provide evidence of Objective 2.	respond to situations where: • relationships and interactions are obvious and have few elements • the required procedure is – clear from the way the question is posed – in a context that has been a focus of prior learning
Complex familiar	20%	These questions can focus on any of the objectives.	respond to situations where: • relationships and interactions have a number of elements and connections are made with knowledge, concepts and principles in relation to aerospace operational systems • the required procedure is – clear from the way the question is posed – in a context that has been a focus of prior learning
Complex unfamiliar	20%	Typically, these questions focus on Objectives 3, 5 and 7.	choose and apply appropriate procedures in a situation where: • relationships and interactions have a number of elements and connections are made with knowledge, concepts and principles in relation to aerospace operational systems • the required procedure is – not clear from the way the question is posed – in a context in which students have had limited prior experience.

Conditions

- Time allowed
  - Perusal time: 5 minutes
  - Working time: 120 minutes
- Students may use
  - a non-programmable scientific and flight calculator
  - QCAA-approved analog slide rule type and aviation plotter or protractor and ruler.
- Students must not bring notes into the examination.
- The QCAA provides the QCAA Aerospace Systems formula sheet.

Glossary

The syllabus glossary is available at www.qcaa.qld.edu.au/downloads/senior-qce/common/snr_glossary_cognitive_verbs.pdf.

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Version history

Version	Date of change	Information
1.0	January 2024	Released for familiarisation and planning (with implementation starting in 2025)