



National Unit Specification: general information

UNIT Theory of Flight (SCQF level 6)

CODE F5GT 12

SUMMARY

This Unit may form part of a National Qualification Group Award but may also be offered on a free-standing basis.

This largely theoretical Unit is designed to allow candidates to develop a basic knowledge and understanding of the theory of flight. During delivery of the Unit candidates will investigate the main forces and force balance acting on an aircraft in flight. They will also develop the knowledge and understanding to describe basic aerofoil sections and lift generation in aircraft. Candidates will also learn about the main drag forces acting on aircraft and methods of reducing these forces. They will also develop the knowledge and understanding to describe moment balance and static stability of an aircraft in flight.

This Unit is suitable for candidates who:

- ◆ are undertaking the study of this subject for the first time
- ◆ wish to gain a basic knowledge and understanding of the theory of flight
- ◆ are considering a career in the aviation industry and wish to gain a basic knowledge and understanding of the theory of flight

OUTCOMES

- 1 Investigate the main forces and force balance acting on an aircraft in flight.
- 2 Describe the basic principles of aerofoil sections and lift generation in aircraft.
- 3 Describe the main types of drag forces and methods of drag reduction in aircraft.
- 4 Describe the moment balance and static stability of an aircraft in flight.

Administrative Information

Superclass: XP

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National Unit Specification: statement of standards

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit Specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME 1

Investigate the main forces and force balance on an aircraft in flight.

Performance Criteria

- (a) Sketch correctly the main forces acting on an aircraft in flight.
- (b) Evaluate correctly the balanced forces on an aircraft in flight.
- (c) Sketch correctly the resolution of lift to describe the force balance on an aircraft while climbing and descending.
- (d) Sketch correctly the resolution of lift to describe the force balance on an aircraft in constant-speed level turning.

OUTCOME 2

Describe the basic principles of aerofoil sections and lift generation in aircraft.

Performance Criteria

- (a) Describe correctly the venturi effect and aerodynamic force.
- (b) Describe correctly downwash, continuously downward momentum of airflow and lift generation.
- (c) Describe correctly, with the aid of diagrams, aerofoil sections.
- (d) Describe correctly, with the aid of diagrams, pressure distribution on an aerofoil.
- (e) Describe correctly the effects of angle of attack and relative air flow on lift.

OUTCOME 3

Describe the main types of drag forces and methods of drag reduction in aircraft.

Performance Criteria

- (a) Identify correctly the main types of drag.
- (b) Describe correctly different forms of parasite drag on an aircraft.
- (c) Describe correctly induced drag on an aircraft.
- (d) Identify correctly methods for drag reduction.

National Unit Specification: statement of standards (cont)

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OUTCOME 4

Describe the moment balance and static stability of an aircraft in flight.

Performance Criteria

- (a) Describe correctly the term centre of gravity of an aircraft.
- (b) Describe correctly the term centre of pressure of an aerofoil.
- (c) Describe correctly, with the aid of a diagram, the moment balance of an aircraft in flight.
- (d) Describe correctly the static stability of an aircraft in flight.

EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or recorded oral evidence should be produced to demonstrate that candidates have achieved all the Outcomes and Performance Criteria.

Outcomes may be assessed on an individual basis, as a combination of Outcomes or as a single, holistic assessment covering all four Outcomes. Assessment(s) must be conducted under supervised, closed-book conditions in which candidates may use reference materials provided by the centre but are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment. The total time set aside for assessment must not exceed 3 hours.

With regard to Outcome 1

- ◆ The four main forces acting on aircraft must be sketched
- ◆ The balance of forces on an aircraft must be evaluated in level, straight, constant speed flight only
- ◆ Only straight constant speed climbing and descending must be considered

With regard to Outcome 2

- ◆ A minimum of two aerofoil sections should be described

With regard to Outcome 3

- ◆ Three methods for drag reduction must be identified

With regard to Outcome 4

- ◆ Written and/or recorded oral evidence as described in the Performance Criteria

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

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This part of the Unit Specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

This Unit forms part of the National Qualification Group Award in Aeronautical Engineering at SCQF level 6, but may also be offered on a free-standing basis.

It is strongly recommended that the Unit *Aeronautical Engineering: Fundamentals* at SCQF level 6 be delivered to candidates before this Unit.

This Unit is designed to allow candidates to develop a basic knowledge and understanding of the theory of flight. On successful completion of the Unit candidates will be able to describe the main forces and force balance acting on an aircraft in flight. They will also have the knowledge and understanding to describe basic aerofoil sections and lift generation in aircraft. Candidates will also be able to describe the main drag forces acting on aircraft and methods of reducing these forces. They will also be able to describe the moment balance and static stability of an aircraft in flight.

The list below shows a suggested range of topics which may be delivered to candidates to support and underpin the requirements set out in the Outcomes, Performance Criteria and Evidence Requirements.

1 Investigate the main forces and force balance acting on an aircraft in flight.

- ◆ Forces on aircraft in flight:
 - explain the four lumped forces acting at the centre of gravity of an aircraft: thrust, drag, lift, weight
- ◆ Force balance on an aircraft in level, straight, constant-speed flight:
 - evaluate the balanced forces on an aircraft in level, straight, constant-speed flight
- ◆ Graphical expression of force resolution:
 - sketch the resultant force of two forces acting on perpendicular direction
 - sketch the force resolution (into two perpendicular forces)
- ◆ Force balance on an aircraft in straight, constant-speed climbing and straight, constant-speed descending
- ◆ Force balance on an aircraft in constant-speed level turning:
 - Centripetal force and aircraft turning
 - use sketch to explain the lift force resolution and force balance on an aircraft in constant-speed level turning

National Unit Specification: support notes (cont)

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2 Describe the basic principles of aerofoil sections and lift generation in aircraft.

- ◆ Venturi effect and relevant aerodynamic force at low speed airflow
- ◆ Airflow downwash, downward momentum of airflow and lift generation
- ◆ Aerofoil parameters and sections:
 - chord
 - thickness
 - mean camber line
 - thickness to chord ratio
 - high lift aerofoil
 - general purpose aerofoil
 - high speed aerofoil
- ◆ Pressure distribution on an aerofoil
- ◆ Effects of angle of attack on lift
- ◆ Laminar and turbulent airflow and flow separation

3 Describe the main types of drag forces and methods of drag reduction in aircraft.

- ◆ Parasite drag and induced drag
- ◆ Different forms of parasite drag:
 - pressure drag (or form drag)
 - skin friction drag
 - interference drag
- ◆ Effects of skin smoothness on drag
- ◆ Effects of streamlined shape on drag
- ◆ Effects of fairings on drag

4 Describe the moment balance and static stability of an aircraft in flight.

- ◆ The concept of force and its moment with respect to a pivot point
- ◆ The concept of centre of gravity of an aircraft
- ◆ The concept of centre of pressure of an aerofoil
- ◆ Moment balance of an aircraft in flight
- ◆ The concept of static stability of an aircraft in flight

National Unit Specification: support notes (cont)

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GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is recommended that the Unit is delivered in the same sequence the Outcomes are presented in the National Unit Specification: statement of standards section of the Unit. The Unit may be delivered by a combination of lectures, tutorial work, group work, computer simulation and practical work. While the majority of the Unit can be delivered in a classroom it is recommended that candidates undertake some investigative work (eg using the Internet, computer simulation software etc.) and practical experimental work (eg experiments involving the use of a wind tunnel etc.) to confirm and reinforce the theory taught in the Unit.

The use of aircraft models, DVDs, CDs, videos and posters to illustrate principles behind the theory of flight would greatly assist candidate learning.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Candidates have to be able to work confidently with a number of complex numerical and graphic concepts in order to identify, interpret and present relevant information. The ability to calculate, describe and sketch data is integral to achievement. Access to dedicated software and/or on-line tutorials may provide useful support during formative work. Undertaking on-line investigative research to support knowledge and understanding could enhance the ability to analyse, summarise and evaluate complex technical data. Consideration for other technology users and adherence to procedures ensuring security and safety should be routine. Group discussion during practical experimental work would help to reinforce understanding and develop oral communication skills in a work related context. Guidance should be given on requirements for written evidence, which should be accurate and clearly expressed; examples of technical reports could be provided to indicate acceptable standards.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Centres are encouraged to use formative assessment extensively as it plays a particularly important role in allowing candidates to develop a sound knowledge and understanding of the principles underpinning the theory of flight.

Where assessment is carried out on an individual Outcome basis the assessment papers may consist of short answer and restricted-response questions, or objective questions (eg multi-choice questions), or a mixture of both. Individual assessment events may last no longer than 45 minutes. It is recommended that each assessment event is carried out after the completion of the delivery of the corresponding Outcome. Assessment papers may be suitable for on-line delivery.

National Unit Specification: support notes (cont)

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Where Outcomes are assessed using a single, holistic assessment the assessment paper may consist of short answer and restricted response questions, or objective questions or a combination of both. The assessment paper may be suitable for on-line delivery.

DISABLED CANDIDATES AND/OR THOSE WITH ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website www.sqa.org.uk/assessmentarrangements