



Higher National Unit specification

General information

Unit title: Advanced Composite Materials (SCQF level 8)

Unit code: H94P 35

Superclass: XA

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Version: 01

Unit purpose

This Unit is designed to allow learners to acquire a knowledge and understanding of advanced composite materials. This Unit will prepare learners for a role in the design of composite structures and also provide a foundation for further study of the structural behaviour of composite materials. The Unit is primarily aimed at learners who wish to work in the aircraft engineering sector but may also be of benefit to those in other engineering sectors where composite materials may be in use.

Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Analyse the composition and manufacture of advanced composite materials.
- 2 Evaluate the elastic properties of a composite lamina.
- 3 Analyse the experimental characterisation of composite materials.

Credit points and level

1 Higher National Unit credit at SCQF level 8: (8 SCQF credit points at SCQF level 8)

Recommended entry to the Unit

Access to this Unit is at the discretion of the centre. The Unit has no pre-requisites; however, it would be beneficial if the learner has a basic knowledge of aircraft and/or engineering theory specifically in the area of statics and strength of materials. This could be evidenced by completion of the HNC Aircraft Engineering Group Award.

Higher National Unit Specification: General information (cont)

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Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

Higher 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

Analyse the composition and manufacture of advanced composite materials.

Knowledge and/or Skills

- ◆ Composite material terminology and applications
- ◆ Types and properties of fibre reinforcement and matrices
- ◆ Interface between the fibre and the matrix
- ◆ Particulate and fibre reinforcement configurations
- ◆ Manufacturing, layup and storage of composite materials
- ◆ Laminate stacking notation, symmetry, balance and coupling effects
- ◆ Health and safety considerations of working with advanced composite materials

Outcome 2

Evaluate the elastic properties of a composite lamina.

Knowledge and/or Skills

- ◆ Volume and weight fraction
- ◆ Constituent part load sharing
- ◆ Longitudinal, transverse and shear moduli
- ◆ Halpin-Tsai equations
- ◆ Anisotropic properties of a lamina
- ◆ Effect of fibre orientation on the elastic properties of a lamina

Outcome 3

Analyse the experimental characterisation of composite materials.

Knowledge and/or Skills

- ◆ Types of test carried out to characterise composite material properties
- ◆ Composite material damage
- ◆ Damage detection techniques

Higher National Unit specification: Statement of standards (cont)

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Evidence Requirements for this Unit

Assessment for Outcomes 1 to 3 could be done on an Outcome by Outcome basis or as a combined assessment event, under closed-book supervised conditions.

Alternatively, assessment for Outcomes 1 and 2 could be done on an Outcome by Outcome basis or as a combined assessment event, under closed-book supervised conditions. Assessment for Outcome 3 could be generated under open-book conditions.

Outcome 1

Learners will need to provide written and/or oral recorded evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ describe common composite material terminology and applications.
- ◆ describe types and properties of fibre reinforcement and matrices.
- ◆ analyse the interface between the fibre and the matrix.
- ◆ analyse particulate and fibre reinforcement configurations.
- ◆ analyse manufacturing, layup and storage of composite materials.
- ◆ describe laminate stacking notation, symmetry, balance and coupling effects.
- ◆ analyse health and safety considerations of working with advanced composite materials.

Outcome 2

Learners will need to provide written and/or oral recorded evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ evaluate volume and weight fractions for composite materials.
- ◆ evaluate constituent part load sharing.
- ◆ evaluate longitudinal, transverse and shear moduli.
- ◆ analyse Halpin-Tsai equations.
- ◆ evaluate the anisotropic properties of a lamina.
- ◆ analyse the effect that fibre orientation has on the elastic properties of a lamina.

Outcome 3

Learners will need to provide written and/or oral recorded evidence to demonstrate their Knowledge and/or skills by showing that they can:

- ◆ analyse the test methods used to characterise composite material properties.
- ◆ analyse composite material damage.
- ◆ analyse composite material damage detection techniques.



Higher National Unit Support Notes

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Unit Support Notes are offered as guidance and 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 is designed to allow learners to acquire a knowledge and understanding of advanced composite materials. This Unit will prepare learners for a role in the design of composite structures and also provide a foundation for further study of the structural behaviour of composite materials. The Unit is primarily aimed at learners who wish to work in the aircraft engineering sector but may also be of benefit to those in other engineering sectors where composite materials may be in use. This Unit is an optional Unit in the HND Aircraft Engineering but may be appealing for other Engineering qualification frameworks or as stand-alone Unit.

Outcome 1

The content of Outcome 1 should initiate with the definition of a composite material and develop common terminology to enable learners to progress to the more challenging elements of the Unit with secure knowledge of terminology which, at the outset may be unfamiliar to them. Applications for composite materials should be discussed to highlight their widespread use. The types and properties of fibre and matrices should be presented and the advantages and disadvantages of each type should be explained. The importance of the interface between the fibre and the matrix should be analysed considering the mechanical properties and composite performance for both dis-continuous and continuous fibres. Particulate and fibre reinforcement configurations should be examined with particular attention paid to fibre reinforcement and the advantages and disadvantages of each type. The manufacture of the fibre and matrix should be explained prior to the analysis of layup techniques commonly employed. Health and safety associated with composite materials and the storage of composite materials should be analysed. Manufacturing drawings and/or Structural Repair Manual (SRM) extracts incorporating laminate stacking notation for angle ply laminates should be utilised to demonstrate how the tailoring of composite laminate plies is presented in the manufacturing/repair environment. Following the explanation of laminate orientation notation the importance of balance and symmetry to the coupling effects are analysed.

Higher National Unit Support Notes (cont)

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Outcome 2

The content of Outcome 2 lends itself to a quantitative rather than qualitative description although some explanations are intended as descriptive only. The total volume and weight of a composite material consists of the relative proportions of reinforcement and matrix. The importance of the respective proportions to lamina behaviour is displayed through the volume and weight fraction formulae and the conversion between them. The longitudinal behaviour of unidirectional composites is evaluated by considering constituent part load sharing. Simple approaches to longitudinal, transverse and shear moduli should be evaluated leading to the analysis of Halpin-Tsai equations and in particular the differences between the former and latter approaches for the shear and transverse moduli. The anisotropic properties of a lamina are developed from the six stress and six strain components for an isotropic material to Hooke's Law leading to the constitutive equations written in matrix notation, the differences in behaviour between isotropic and anisotropic materials should be evident from this. In the knowledge that lamina are often orientated the effect of fibre orientation on the elastic properties should be analysed.

Outcome 3

This Outcome should analyse a range of material and non-destructive testing approaches to identify material properties and defects. The range of material testing methods should include; void volume fraction, constituent weight and volume fraction, density, thermal expansion coefficients, moisture absorption and diffusivity, tensile, compression, shear, flexural and fracture toughness. Common damage associated with the fibre and matrix and production and in-service should be analysed. Non-destructive testing methods used to detect defects including ultrasonics, shearography, thermography, x-radiography and acoustic emission should also be analysed.

Guidance on approaches to delivery of this Unit

It is logical to deliver this Unit sequentially by Outcome as much of the terminology associated with composite materials will be introduced in Outcome 1. Whilst the mode of delivery is at the discretion of the centre it is anticipated that traditional lectures will be supplemented by the use of widely available videos and material samples. It is expected that videos of layup techniques, non-destructive testing (NDT) and material testing will add greatly to the learning experience in these areas. Having access to relevant publications including Maintenance Manuals (AMM) and Structural Repair Manuals (SRM) will enable composite notations to be presented in the form that the learners may discover in a working environment.

The Knowledge and/or Skills are written in a manner which should allow them to be delivered in the sequence presented as the subsequent concepts increase in complexity.

Higher National Unit Support Notes (cont)

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Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Holistic assessment is encouraged and learners could be assessed by a single one and half hour closed-book supervised assessment covering all three Outcomes. Alternatively, centres may choose to assess Outcomes 1 and 2 as a closed-book supervised 1 hour assessment and Outcome 3 as a report.

Closed-book supervised assessment could be comprised of a number of multiple-choice and extended response questions enabling Unit Evidence Requirements to be met and breadth and depth of learner knowledge to be demonstrated. This assessment approach should reduce the frequency of assessment/re-assessment events and ensure more time is afforded for teaching and learning whilst meeting the Evidence Requirements of the Unit.

Accurate records should be made of the assessment instruments used showing how evidence is generated for each assessment/examination, giving marking schemes and/or checklists, etc. Records of learners' achievements should be kept. These records will be available for external verification.

Where closed-book supervised assessment is specified then learners should not know in advance the questions on which they will be assessed and different questions should be set on each assessment occasion. This assessment must be carried out under closed-book supervised conditions. In order to gain an assessment pass, learners will need to demonstrate that they can achieve the minimum requirements for this Unit. If a report is selected as a means of meeting the Evidence Requirements for Outcome 3 then centres are encouraged to, where possible, use originality software to confirm the authenticity of learners' work.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at www.sqa.org.uk/e-assessment.

Higher National Unit Support Notes (cont)

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Opportunities for developing Core and other essential skills

There are opportunities to develop the Core Skill of *Communication* (Written Communication) and *Numeracy* (Using Number) at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components. This could be achieved through accurate written and numeric answers to formative and summative assessment questions.

History of changes to Unit

Version	Description of change	Date

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General information for learners

Unit title: Advanced Composite Materials (SCQF level 8)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit is designed to allow you to acquire a knowledge and understanding of advanced composite materials. This Unit will prepare you for a role in the design of composite structures and also provide you with a foundation for further study of the structural behaviour of composite materials.

This Unit is primarily intended for those who are interested in aircraft engineering either in a practical maintenance role or if you intend to undertake an engineering function such as design. This Unit is offered as an optional Unit in the HND Aircraft Engineering Group Award however may also be of interest to other engineering sectors where composite materials are also extensively found, eg renewables.

The Unit has three main areas, each area covered by a separate Outcome. At the end of the Unit you will be able to:

- 1 Analyse the composition and manufacture of advanced composite materials.
- 2 Evaluate the elastic properties of a composite lamina.
- 3 Analyse the experimental characterisation of composite materials.

The assessment strategy will be determined by the centre. All of the Knowledge and/or Skills contained in the three Outcomes will be assessed and to complete the Unit successfully you will have to achieve a satisfactory level of performance in the assessment event/s.

You will have opportunities to develop the Core Skill component of *Communication* (Written Communication) and *Numeracy* (Using Number) at SCQF level 6 in this Unit. This could be achieved through accurate written and numeric answer to formative and summative assessment questions.