Higher National Unit specification

General information

Unit title: Physics for Aviation (SCQF level 7)

Unit code: H94D 34

Superclass: RC

Publication date: May 2015

Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This Unit is designed to provide learners with the necessary knowledge, understanding and skills in physics subjects needed to solve engineering problems in an aviation context. The Unit is delivered using an applications approach to solve fundamental aircraft engineering problems in solid mechanics, thermofluids, wave motion and mechanical vibration. Such applications will provide a foundation to progress to further studies in aerodynamics, aircraft structural mechanics and aircraft systems as well as fibre optic technology used in modern avionics.

The Unit is primarily aimed at those learners who wish to pursue a career in aircraft engineering and is a mandatory Unit in the HNC and HND Aircraft Engineering Group Awards, although it may be of interest to learners of other engineering disciplines.

Outcomes

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

1 Explain and apply the concepts, theories and principles used to solve engineering solid mechanics problems.
2 Explain and apply the concepts, theories and principles used to solve engineering thermofluid problems.
3 Explain and apply the concepts, theories and principles used to solve wave motion and vibration problems.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Higher National Unit Specification: General information (cont)

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Recommended entry to the Unit

Entry is at the discretion of the centre. However, good knowledge and skills in Mathematics and Physics at SCQF level 6 would be an advantage to learners.

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Using Number at SCQF level 6

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.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website **(http://www.sqa.org.uk/sqa/46233.2769.html)**.

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.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Explain and apply the concepts, theories and principles used to solve engineering solid mechanics problems.

Knowledge and/or Skills

- Conservation laws
- Statically determinate force systems
- Kinematic motion
- Rigid body dynamics
- Stress and strain
- Thermal effects

Outcome 2

Explain and apply the concepts, theories and principles used to solve engineering thermofluid problems.

Knowledge and/or Skills

- Thermofluid conservation laws
- Fluid statics
- Fluid dynamics
- Thermodynamic processes
- Heat transfer

Outcome 3

Explain and apply the concepts, theories and principles used to solve wave motion and vibration problems.

Knowledge and/or Skills

- Wave motion
- Light
- Sound
- Vibration

Higher National Unit specification: Statement of standards (cont)

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Evidence Requirements for this Unit

The assessment for this Unit can be done on an Outcome by Outcome basis, or as a combined assessment of two or more Outcomes. Learners are required to provide written and/or oral recorded evidence, generated under closed-book supervised conditions.

Evidence for the Knowledge and/or Skills in all three Outcomes will be generated through sampling. Any sampling process must be 'unseen' by the learner before the assessment. That is, learners are expected to fully prepare the range of Knowledge and/or Skills and not be able to predict a chosen sample.

Outcome 1

Learners will need to provide written and/or oral recorded evidence, generated under closed-book supervised conditions, to demonstrate that they can meet the requirements of three of the six Knowledge and/or Skills items, applied in an aviation context, by showing that they can:

- explain and apply the laws relating to conservation of momentum and energy for solid bodies.
- solve problems involving statically determinate force systems.
- solve problems involving linear, angular and combined kinematic motion problems.
- solve problems involving linear, angular and combined rigid body dynamics.
- solve problems involving stress and strain for rod, beam and plate elements including simple assemblies.
- solve problems involving linear and volumetric expansion of solids.

Outcome 2

Learners will need to provide written and/or oral recorded evidence, generated under closed-book supervised conditions, to demonstrate that they can meet the requirements of three of the five Knowledge and/or Skills items, applied in an aviation context, by showing that they can

- explain and apply the laws relating to the conservation of mass, momentum and energy (1st law of thermodynamics) for steady thermofluid systems.
- solve problems involving hydrostatic behaviour of liquids and gases.
- solve problems involving steady fluid flow behaviour of liquids and gases.
- solve problems involving steady thermodynamic behaviour of liquids and gases.
- solve problems involving the steady state transfer of heat.

Higher National Unit specification: Statement of standards (cont)

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Outcome 3

Learners will need to provide written and/or oral recorded evidence, generated under closed-book supervised conditions, to demonstrate that they can meet the requirements of two of the four Knowledge and/or Skills items, applied in an aviation context, by showing that they can:

- explain the propagation and characteristics of light and sound waves.
- solve problems involving the transmission, reflection, refraction and diffraction of light waves.
- solve problems involving the transmission, reflection of sound wave.
- solve problems involving oscillatory motion and mechanical vibration.

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 knowledge, understanding and skills in physics subjects needed to solve engineering problems in an aviation context. The Unit is delivered using an applications approach to solve fundamental aircraft engineering problems in solid mechanics, thermofluids, wave motion and mechanical vibration. Such applications will provide a foundation to progress to further studies in aircraft aerodynamics, aircraft structural mechanics and aircraft systems as well as the basis of fibre optic technology used in modern avionics.

Although this Unit may be of interest to learners of other engineering disciplines, it is primarily aimed at those learners who wish to pursue a career in aircraft engineering. It is offered as a mandatory Unit in the HNC and HND Aircraft Engineering Group Awards but also serves as a stand-alone Unit.

Outcome 1

The content of Outcome 1 should start with the identification of parameters and their Units applicable to the solution of solid body mechanics. This could lead into an explanation and application of the conservation equations governing linear and angular rigid body mechanics in respect of momentum, impulse and energy, including the relationships between rate of change of momentum and energy as force/torque and power respectively. An introduction to statically determinate force systems should start with equilibrium concepts, the identification of different types of loads (friction, direct, shear, bending, torque and pressurisation) on systems and the concept of free body diagrams. Learners should practice solving statically determinate force problems to include planar beams, frameworks and shafts to establish their external reactions. Such problems could be related to elements of an airframe structure. Following a review of the kinematic and dynamic relationships, learners should practice solving problems of a linear, angular and combined motion nature. It is important that learners understand gyroscopic action and the applications within an aircraft context such as navigation/attitude instruments and airframe/engine interactions during aircraft manoeuvring. Following definitions of, and relationships between, stress and strain, for both direct and shear internal loads, learners should practice solving stress and strain problems for rod, beam, and plate elements as well as for simple assemblies' representative of typical airframe components. Learners should also be able to solve problems involving linear and volumetric expansion of materials.

Higher National Unit Support Notes (cont)

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Outcome 2

The content of Outcome 2 should start with the identification of parameters and their Units applicable to the solution of fluid statics, fluid dynamics, heat and thermodynamics problems. Such an introduction should embrace an explanation of fluid types and their properties and dependencies including phase changes. Learners also need to be familiar with categories of uniform fluid flow such as incompressible/compressible, inviscid/viscous, laminar/turbulent and streamline behaviour, and their consequences and constraints. This could lead into an explanation and applications of the one-dimensional conservation equations governing steady thermofluid behaviour in respect of mass, momentum and energy (1^{st} law of thermodynamics) in which the definitions of flow work and enthalpy must be included. Following the explanation of fluid types, learners should use hydrostatic relationships to practice solving fluid static problems which should include manometers and hydrostatic systems representative of aircraft applications. Learners should also have awareness of the International Standard Atmosphere (ISA) and of buoyancy effects. Following the explanation of fluid flow categories, learners should use fluid dynamic relationships to practice solving problems of steady uniform incompressible fluid flow through convergent/divergent nozzles and over external surfaces typical of those relevant to aircraft application. During this topic, learners should gain the ability to define and interpret streamline behaviour, stagnation conditions, viscous boundary layers and airspeed zones (subsonic, transonic and supersonic) together with the definitions and applications of relevant non-dimensional quantities such a Reynolds number and Mach number. Learners should be taught how to pose the Steady Flow Energy Equation (SFEE) in a power form as well as an energy form for non-flow and flow processes, and for systems with closed and open boundaries. They should then be able to make valid assumptions to reduce the SFEE to Bernoulli's equation in pressure and head form. Learners must also gain knowledge of measurement of pressure and velocity in a fluid flow. An introduction to thermodynamics could start by highlighting the statistical nature of this subject which can lead into explanations of thermal equilibrium, laws of thermodynamics and entropy related to changes in heat levels as well as irreversibility and inefficiencies in thermofluid closed and open systems. Learners should use relationships to practices solving thermofluid processes problems as well as relating the variables in a thermodynamic cycle as a cycle diagram, such as those of thermofluid machines, in terms of pressure, volume, temperature, enthalpy and entropy. Learners must also gain a critical awareness of measurement of temperature. An explanation of heat energy, heat transfer and modes of heat transfer including combustion, together with the associated modes and phase changes should lead to learners using relationships to practice solving elementary heat transfer problems representative of aircraft applications.

Higher National Unit Support Notes (cont)

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Outcome 3

The content of Outcome 3 should start with the identification of parameters and their Units applicable to the solution of wave motion problems. For light waves, this should include explanations and applications of the electromagnetic spectrum, oscillating E and B fields, and polarisation. For sound waves, this should include explanations and applications of sound pressure level, perceived loudness and harmonics. Following the explanation of light waves and their characteristics, learners will use relationships to solve light transmission problems. Learners should also be able to explain fibre optic transmissions and their applications in aircraft. Following the explanation of sound waves and their characteristics, learners will use relationships to solve sound transmission problems. Learners should develop the ability to define and interpret the factors affecting the speed of sound through different mediums as well as an understanding of the Doppler affect for moving sources and moving observers. They should also have an understanding of the sound barrier concept and the sonic boom for high speed aircraft. An explanation of Simple Harmonic Motion (SHM) could be used to introduce the basis of vibrations before expanding into the differential equations representing mass-spring-damper systems for linear and angular mechanical systems. Learners should use these relationships to practice the solution of simple mechanical vibration problems.

Guidance on approaches to delivery of this Unit

This Unit may be delivered in any order of Outcomes as each Outcome covers self-contained topics. For each Outcome, the Knowledge and/or Skills are written in a sequence that allows their delivery to increase in complexity through the Outcome. Whilst the development of concepts and theories is essential, the emphasis on delivery should be that of applying these in an aircraft engineering context through a problem based learning approach. It is envisaged that formative assessment practice would be an integral part of the learning and teaching as an approach to ensure that learners are well prepared for summative assessment. The mode of delivery is at the discretion of the centre although it is anticipated that traditional lectures and tutorials will be supplemented by the use of laboratory demonstrations and widely available short videos clips. Learners could also develop skills of independent study through access and use of a Virtual Learning Environment.

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 two hour closed-book supervised assessment covering all three Outcomes. Alternatively, centres may choose to assess on an Outcome by Outcome basis by separate assessments each of 30 minutes duration for Outcomes 1 and 3, with one hour for Outcome 2, or as two or more Outcomes together, under closed-book supervised conditions.

Irrespective of which assessment strategy is adopted, assessments should contain the sample of the Knowledge and/or Skills requirements for each Outcome as detailed in the Statement of Standards. Any sampling process must be 'unseen' by the learner before the assessment. That is, learners are expected to fully prepare the range of Knowledge and/or Skills and not be able to predict a chosen sample and different questions should be set on each assessment occasion.

Closed-book supervised assessment could comprise of a number of multiple choice, short response questions and extended response questions enabling Unit Evidence Requirements to be met and the breadth and depth of learner knowledge to be demonstrated.

Accurate records should be made of the assessment instruments used, together with marking schemes, showing how evidence is generated for each assessment/examination. Second marking of learner's assessment scripts should be undertaken for a representative sample in accordance with the Centre's Quality Assurance Procedures. Records of learners' achievements should be kept. These records will be available for external verification.

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**.

Opportunities for developing Core and other essential skills

There are opportunities to develop the Core Skill of *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 answer to formative and summative extended response questions.

The specific Knowledge and Skills developed within this Unit will support a learner's employability development, as engineering employers seek people with science and numeracy knowledge and skills. Furthermore, through self-directed learning activities, including the use of the Internet and a Virtual Learning Environment, learners will have the opportunity to develop independent learning skills, and so gain an edge when seeking employment.

This Unit has the Using Number component of Numeracy embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Using Number at SCQF level 6.

History of changes to Unit

Version	Description of change	Date
02	Core Skills Component Using Number at SCQF level 6 embedded.	September 2015

General information for learners

Unit title: Physics for Aviation (SCQF level 7)

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 provide you with the necessary knowledge, understanding and skills in physics subjects needed to solve engineering problems in an aviation context. The Unit is delivered using an applications approach to solve fundamental aircraft engineering problems in solid mechanics, thermofluids, wave motion and mechanical vibration. Such applications will provide a foundation to progress to further study in aerodynamics, aircraft structural mechanics and fibre optic transmission.

The Unit is primarily aimed at those learners who wish to follow a career in aircraft engineering and is offered as a mandatory Unit in the HNC/HND Aircraft Engineering Group Awards, although it may be of interest to learners of other engineering disciplines.

The Unit has three main topic areas, each area covered by a separate Outcome as follows:

1 Explain and apply the concepts, theories and principles used to solve engineering solid mechanics problems.
2 Explain and apply the concepts, theories and principles used to solve engineering thermofluids problems.
3 Explain and apply the concepts, theories and principles used to solve wave motion and vibration problems.

During the Unit, you will learn through lectures, tutorials and practical activities as well as through independent learning studies as directed by your lecturers. In this way, you will learn how to apply concepts and principles to engineering problems of relevance to aircraft applications. Through such problem based learning you will also develop skills in the use of applicable mathematics.

The assessment event(s) for this Unit will consist of written and/or oral recorded evidence, generated under closed-book supervised conditions. 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 *Numeracy* (Using Number) at SCQF level 6 in this Unit. This could be achieved through accurate written and numeric answer to formative and summative extended response questions.

The specific Knowledge and Skills developed within this Unit will support your employability development, as engineering employers seek people with science and numeracy knowledge and skills. Furthermore, through self-directed learning activities, including the use of the Internet and a Virtual Learning Environment, you will have the opportunity to develop independent learning skills, and so gain an edge when seeking employment.