National Unit Specification: general information

UNIT Thermofluids (SCQF level 6)

CODE F5JE 12

SUMMARY

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

This Unit is designed to provide candidates with knowledge and understanding of engineering thermofluids. During delivery of the Unit candidates will learn to determine the properties of working fluids and sketch thermodynamic properties on pressure-volume (p-V) diagrams. Candidates will also develop the knowledge and understanding to solve problems involving the non-flow and steady flow energy equations and solve problems relating to hydrostatic pressure and pressure measurements. Candidates will also learn to solve problems involving the application of the mass continuity and Bernoulli's equations as applied to incompressible flow in pipes.

This Unit is suitable for candidates training to be mechanical or multi-disciplinary engineering technicians.

OUTCOMES

1 Determine properties of working fluids.
2 Solve problems involving the non-flow and steady flow energy equations.
3 Solve hydrostatic and fluid pressure problems.
4 Solve problems involving the application of the mass continuity and Bernoulli's equation to incompressible flow in pipes.

Administrative Information

Superclass: RC

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Source: Scottish Qualifications Authority

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National Unit Specification: general information (cont)

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RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

- Standard Grade Mathematics at credit level
- Standard Grade Physics at credit level
- Intermediate 2 Physics

CREDIT VALUE

1 credit at SCQF level 6 (6 SCQF credit points at SCQF level 6*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates*.

CORE SKILLS

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

This Unit provides opportunities for candidates to develop aspects of the following Core Skills:

- Numeracy (SCQF level 6)
- Problem Solving (SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

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

Determine properties of working fluids

Performance Criteria

(a) Explain correctly the meaning of the term working fluid and the concept of the state of the working fluid.
(b) Solve correctly simple problems using the gas equations.
(c) Sketch correctly a thermodynamic process on a p-V diagram for an ideal gas.
(d) Extract correctly the properties of vapours using thermodynamic property tables.

OUTCOME 2

Solve problems involving the non-flow and steady flow energy equations.

Performance Criteria

(a) State correctly the types of energy and their units relevant to thermodynamic systems.
(b) Solve a problem correctly using the non-flow energy equation for a closed thermodynamic system.
(c) Solve a problem correctly using the steady flow energy equation for an open thermodynamic system.

OUTCOME 3

Solve hydrostatic and fluid pressure problems.

Performance Criteria

a) Calculate correctly hydrostatic pressure for an incompressible fluid.
b) Solve correctly a problem relating to the use of a nanometer to measure the pressure of an incompressible fluid.

National Unit Specification: statement of standards (cont)

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OUTCOME 4

Solve problems involving the application of the mass continuity and Bernoulli's equation to incompressible flow in pipes.

Performance Criteria

(a) Solve a problem correctly using the equation of mass continuity for the flow of an incompressible fluid.
(b) Solve a problem correctly using Bernoulli's equation for the flow of an incompressible fluid through a tapered pipe with a change in height.

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 a candidate has achieved all Outcomes and Performance Criteria.

Outcomes 1, 2, 3 and 4 may be assessed on an individual basis, as a combination of Outcomes (eg Outcomes 1 and 2 assessed together and Outcomes 3 and 4 together), or as a single, holistic assessment covering all four Outcomes. The total time for assessment(s) of the four Outcomes must not exceed 2 hours. 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. Candidates must be provided with an appropriate formulae sheet for assessment(s) and should be allowed to use a non-programmable scientific calculator during assessment(s).

With regard to Outcome 1

- candidates must apply the universal and the characteristic gas equations to an ideal gas, making use of both specific and universal gas constants.
- candidates must determine and use the properties of an ideal gas (both specific and total where appropriate). The properties must include pressure, temperature and volume plus one other from: specific heat, internal energy and enthalpy.
- candidates must sketch one of the following processes for an ideal gas on a p-V diagram: constant pressure, constant volume and constant temperature.
- from given information, candidates must extract the properties of a saturated vapour and a superheated vapour from thermodynamic property tables (both specific and total where appropriate). The properties must include two from dryness fraction, internal energy and enthalpy.

National Unit Specification: statement of standards (cont)

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With regard to Outcome 2

- candidates must identify three of the following forms of energy, and their units, relevant to thermodynamic systems: heat, work, kinetic energy, gravitational potential energy, pressure energy, internal energy and enthalpy.
- given the non-flow energy equation, candidates must solve a problem relating to energy transfers in processes taking place in simple closed systems. The working fluid must be either an ideal gas or a vapour, and values of properties should be determined as appropriate for the fluid.
- given the steady flow energy equation, candidates must solve a problem relating to energy transfers in simple open systems. The working fluid must be either an ideal gas or a vapour and values of properties should be determined as appropriate for the fluid.

With regard to Outcome 3

- candidates must make use of both mass density and relative density when calculating hydrostatic pressure at a given depth for an incompressible fluid
- candidates must solve a problem relating to the use of a manometer to measure the pressure of an incompressible fluid, giving the result as both a gauge pressure and an absolute pressure

With regard to Outcome 4

- candidates must use the equation of mass continuity to determine changes in velocity
- candidates must use Bernoulli's equation to determine changes in pressure as an incompressible fluid flows through a tapered pipe with inlet and outlet at different levels

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 Mechanical Engineering at SCQF level 6, but may also be offered on a free standing basis.

The aim of this Unit is to provide candidates with knowledge and understanding of engineering thermofluids. On successful completion of the Unit candidates will be able to determine the properties of working fluids and sketch thermodynamic properties on pressure-volume (p-V) diagrams. They will have developed the knowledge and understanding to solve problems involving the non-flow and steady flow energy equations and will also be able to solve problems relating to hydrostatic pressure and pressure measurements. Candidates will also be capable of solving problems involving the application of the mass continuity and Bernoulli's equations as applied to incompressible flow in pipes.

Due to the complementary nature of their content the delivery of this Unit may be integrated with that of the Unit *Engineering Thermodynamics* at SCQF level 6.

Due to the close relationship between the content of Outcomes 1 and 2, centres may choose to integrate their delivery. In Outcome 1, candidates should be introduced to the concept of the working fluid, and its importance in thermodynamic systems and plant. A limited number of properties should be determined for both ideal gases and vapours, and these should be used to enable p-V diagrams to be drawn for an ideal gas. This knowledge of the working fluid and its properties should be carried forward into Outcome 2 in which energy transfers are calculated for open and closed systems. The emphasis should be on the correct use of the energy equations, rather than simply memorising formulae. With regard to Outcome 2 pc (b) processes covered may typically involve a closed system with a fluid contained in a cylinder behind a piston. In Outcome 2 pc (c) the open system could be a simplified steam plant, or an internal combustion engine, in each case with calculations being based on fluid energy at inlet and outlet, and work and heat energy transfers.

In Outcome 3 hydrostatic pressure within an incompressible fluid should be introduced along with the property of density and the ways in which it is defined. Manometry should be used to illustrate an application of hydrostatic pressure, with candidates solving simple problems involving pressure measurement.

In Outcome 4 Bernoulli's equation should be introduced as a simplified form of the steady flow energy equation, which was covered in Outcome 2. Bernoulli's equation could be used to demonstrate the way in which energy changes from one form to another as a fluid flows through a tapered pipe of varying height. Using Bernoulli's equation together with the equation of mass continuity, candidates should be allowed to solve problems relating to this type of flow, determining changes in velocity and pressure.

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, computer simulation and laboratory work. While the majority of the Unit can be delivered in a classroom centres should allow candidates to undertake practical thermofluid experiments so that they have opportunities to relate theory learnt in the classroom to practice. For example, where equipment exists candidates should be allowed to perform simple experiments involving manometry to calculate fluid pressures.

Computer simulation illustrating different thermofluid concepts and principles may also provide a good source of learning.

The Internet contains a rich source of materials on engineering thermofluids. Wall charts illustrating different thermofluid concepts and principles can also be a very useful learning and teaching aid.

The Unit should be fully supported with relevant learning materials (eg handouts in paper and electronic form, textbooks, on-line materials etc).

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Across all Outcomes candidates apply their knowledge and understanding to manipulate and evaluate equations as they solve problems in engineering thermofluids. They interpret and translate information from pressure volume diagrams for thermodynamic processes and learn how to sketch such diagrams. Numeracy skills will be naturally enhanced, with a focus on the practical use of numerical and graphical data. Formative activities should be designed to develop accuracy and confidence in handling Numeracy concepts in an engineering context. Aspects of the Core Skill of *Problem Solving*, that is, Critical Thinking, Planning and Organising will be naturally developed if candidates relate theory to practice and undertake practical thermofluid experiments selecting appropriate equipment to calculate fluid pressures. Formative activities could also involve assessor feedback to support review and evaluation of problem solving approaches.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Opportunities for the use of 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 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).*

National Unit Specification: support notes (cont)

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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 engineering thermofluid concepts, principles and equations.

Regardless of whether assessment is carried out on an individual basis, as a combination of Outcomes or on a single, holistic basis any assessment paper(s) used may comprise of a suitable balance of short answer, restricted response and structured questions.

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**

History of changes:

Version	Description of change	Date
02	Superclass changed from RC to XH. Change agreed on the basis that the Unit is delivered exclusively in a Mechanical Engineering context and is resource intensive.	31/05/2011