National Unit Specification: general information

UNIT Engineering Thermodynamics (SCQF level 6)

CODE F5JF 12

SUMMARY

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

This is a mainly theoretical Unit designed to provide candidates with knowledge and understanding of Engineering Thermodynamics. During the delivery of the Unit candidates will learn about property changes and energy transfer processes in closed and open thermodynamic systems. They will also develop the knowledge and understanding to describe heat transfer processes and perform simple calculations involving such processes. Candidates will also have an opportunity to investigate in some depth energy transfers in an open system such as an internal combustion engine or basic steam power cycle or refrigerator etc.

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

OUTCOMES

1 Determine property changes and energy transfers for processes in closed systems.
2 Determine property changes and energy transfers in open systems.
3 Describe heat transfer processes in thermodynamic systems and perform calculations involving such processes.
4 Investigate energy transfers in a given open system.

Administrative Information

Superclass: RC

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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, it is strongly recommended that candidates have attained the NQ Unit *Thermofluids* at SCQF level 6, or equivalent, before studying this Unit.

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.

The 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

UNIT Engineering Thermodynamics (SCQF level 6)

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 property changes and energy transfers for processes in closed systems.

Performance Criteria

(a) Explain clearly the principle of conservation of energy with respect to thermodynamic systems.
(b) Identify correctly the forms of energy relevant to processes in closed systems.
(c) State correctly the meaning of each term in the non-flow energy equation.
(d) Solve problems correctly relating to closed systems using the non-flow energy equation.

OUTCOME 2

Determine property changes and energy transfers in open systems.

Performance Criteria

(a) Identify correctly the forms of energy relevant to thermodynamic processes in open systems.
(b) State correctly the meaning of each of the terms in the steady flow energy equation.
(c) Solve problems correctly relating to open thermodynamic systems using the steady flow energy equation.

OUTCOME 3

Describe heat transfer processes in thermodynamic systems and perform calculations involving such processes.

(a) Describe correctly different heat transfer processes.
(b) Calculate correctly heat transfer associated with a single layer, plane wall.

OUTCOME 4

Investigate energy transfers in a given open system.

Performance Criteria

(a) Describe, with the aid of a block diagram, the operation of a given open system.
(b) Determine correctly energy flows and calculate correctly the overall performance efficiency for a given open system.
(c) Draw correctly a simple energy balance diagram for a given open system.

National Unit Specification: statement of standards (cont)

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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 and 3

Outcomes 1, 2, and 3 may be assessed on an individual basis, as a combination of Outcomes, or as a single, holistic assessment covering all three Outcomes. The total time for assessment(s) of the three Outcomes must not exceed 1 hour 30 minutes. 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) which should include only the non-flow energy equation, steady flow energy equation, universal gas equation and universal heat transfer equation. Candidates should be allowed to use a non-programmable scientific calculator during assessment(s).

With regard to Outcome 1

- candidates must identify each of the following forms of energy relevant to closed thermodynamic systems: heat, work, internal energy.
- candidates must apply the non-flow energy equation to determine energy transfers in processes taking place in closed systems. The processes must include: constant pressure, constant volume, constant temperature and adiabatic. The working fluid should include both an ideal gas and a vapour, and properties should be determined as appropriate.

With regard to Outcome 2

- candidates must identify three of the following forms of energy relevant to open thermodynamic systems: heat, work, kinetic energy, pressure energy, gravitational potential energy, internal energy and enthalpy.
- candidates must apply the steady flow energy equation to determine energy transfers in processes taking place in open systems. The working fluid must include both an ideal gas and a vapour, and properties should be determined as appropriate.

With regard to Outcome 3

- candidates must describe the following heat transfer processes:
  - — conduction
  - — convection
  - — radiation
- candidates must calculate heat transfer through a single layer, plane wall by conduction plus convection from one surface of the wall

National Unit Specification: statement of standards (cont)

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Outcome 4

Outcome 4 must be assessed by a single, holistic assessment. Candidate evidence must be gathered under supervised, open-book conditions. Candidate evidence must be between 500 and 750 words plus diagrams and tables of data.

With regard to Outcome 4

- candidates must investigate one of the following open thermodynamic systems:
  - air conditioning
  - basic steam power (single loop only)
  - clorifier
  - condenser
  - heat exchanger
  - IC Engine
  - refrigeration
  - turbine
  - any other suitable type

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

UNIT Engineering Thermodynamics (SCQF level 6)

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 Thermodynamics. On successful completion of the Unit candidates will have learnt about property changes and energy transfer processes in closed and open thermodynamic systems. Candidates will have the knowledge and understanding to be able to describe heat transfer processes and perform simple calculations involving such processes. They will also have investigated in some depth energy transfers in an open system such as an internal combustion engine or basic steam power cycle or refrigerator etc.

In Outcome 1 candidates should learn about property changes and energy transfers in closed thermodynamic systems. Delivery of Outcome content may begin with candidates being taught about the principle of conservation of energy in thermodynamic systems and the forms of energy that apply to processes in closed systems (ie heat, work, internal energy) The concepts of reversibility and the reversible process may be introduced. The non-flow energy equation should be used to solve problems relating to reversible processes in closed systems. Problems should relate to both an ideal gas and a vapour as the working fluid.

In Outcome 2 candidates should be introduced to property changes and energy transfers in open systems. Candidates should be taught the forms of energy that apply in open thermodynamic systems (ie heat, work, kinetic energy, pressure energy, gravitational potential energy, internal energy and enthalpy). The steady flow energy equation should be used to solve problems in open systems. As in Outcome 1 both ideal gases and vapours should be considered.

In Outcome 3 candidates should learn about the mechanisms that underpin the following heat transfer processes: conduction, convection (both natural and forced) and radiation. Candidates should also learn to perform simple heat transfer calculations (ie heat transfer by conduction through a single layer, plane wall and heat transfer as a result of convection from the surface of a single plane wall).

In Outcome 4 candidates should be provided with the opportunity to consolidate and reinforce their earlier studies in the Unit by investigating an open thermodynamic system in some depth. The choice of system(s) is left to centres to choose but it is recommended that the system(s) chosen should reflect as far as possible local industry requirements and candidates' vocational requirements, career progression and personal interests. As part of the investigation candidates should, with the aid of a block diagram, describe the operation of the open system, determine energy flows in the system and calculate the overall system performance efficiency and produce a simple energy balance diagram for the system.

National Unit Specification: support notes (cont)

UNIT Engineering Thermodynamics (SCQF level 6)

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 suitable balance of lectures, tutorial work, computer simulation, practical laboratory work and industrial visits. The majority of the Unit may be delivered in a classroom, but some aspects of the Unit should be delivered in a suitable engineering environment such as a thermodynamics laboratory. Such practical work would help candidates to set the theory learnt in the classroom into a practical engineering context. In a similar way centres may use industrial visits to allow candidates to develop their knowledge and understanding of practical mechanical power plant and the way in which engineering thermodynamics theory applies to such plant.

Video/DVD materials of engineering plant in operation may be useful in illustrating theory in practice.

The Internet contains a rich source of materials on basic engineering thermodynamics.

The Unit should be fully supported with relevant printed learning materials and access to electronic and on-line materials as appropriate.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Using Number Core Skill component at SCQF level 6 may be developed in all four Outcomes while candidates are manipulating and solving equations to solve problems in engineering thermodynamics.

Candidates may have opportunities to develop The Using Graphical Information Core Skill component at SCQF level 6 in Outcome 4 while producing diagrams to support their investigations.

The Critical Thinking Core Skill component at SCQF level 6 may be developed in all four Outcomes while candidates apply thermodynamics theory to solve engineering problems.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Centres are encouraged to use formative assessment as a means of reinforcing the presentation of thermodynamics theory and in developing the ability of the candidates to apply the theory in solving problems.

Outcomes 1, 2 and 3

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 a suitable balance of short answer, restricted response and structured questions.

National Unit Specification: support notes (cont)

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Outcome 4

Outcome 4 may be assessed by means of an assignment. Candidate evidence may be presented in the form of a written report. The exact structure of the report is left to centres to decide although a structure of the following form would be acceptable:

- purpose of investigation
- description of system operation
- energy flows and system efficiency (to include a simple energy balance diagram)
- conclusions

Reports may be completed in the candidate's own time. Centres should make every reasonable effort to ensure that the report is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding.

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)*.

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**