National Unit Specification: general information

UNIT Strength of Materials (SCQF level 6)

CODE F5K9 12

SUMMARY

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

This largely theory based Unit is designed to provide candidates with basic knowledge and understanding of Strength of Materials in an engineering context. During Unit delivery, candidates will learn to use shear force and bending moment diagrams to solve problems involving simply supported beams and cantilevers. They will also develop the knowledge and understanding to apply simple bending theory to idealised beams and apply simple torsion theory to solve problems involving shafts of circular cross-sectional area.

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

OUTCOMES

1 Determine shear forces and bending moments for simply supported beams and cantilevers.
2 Solve idealised beam problems using bending theory.
3 Solve shaft problems using simple torsion theory.

Administrative Information

Superclass: RC

Publication date: May 2011

Source: Scottish Qualifications Authority

Version: 02

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 Physic at Credit level
- Intermediate 2 Physics

CREDIT VALUE

1 credit(s) 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 5)
- Problem Solving (SCQF level 5)

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 shear forces and bending moments for simply supported beams and cantilevers.

Performance Criteria

(a) Reactions are calculated correctly for a statically determinate simply supported beam and cantilever.
(d) Shear force and bending moment diagrams are drawn correctly for a simply supported beam and a cantilever.
(c) The point of zero shear and maximum bending moment is determined accurately.

OUTCOME 2

Solve idealised beam problems using bending theory.

Performance Criteria

(a) The second moment of area is correctly determined for a simple section.
(c) A problem involving simple bending theory is solved correctly.

OUTCOME 3

Solve shaft problems using simple torsion theory.

Performance Criteria

(a) The polar second moment of area is correctly determined for a shaft of circular cross-section.
(b) Problems involving simple torsion theory applied to shafts of circular cross-sectional area are solved correctly.

EVIDENCE REQUIREMENTS FOR THIS UNIT

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

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

National Unit Specification: statement of standards (cont)

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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 should 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 should be allowed to use a non-programmable scientific calculator during assessment.

With regard to Outcome 1

- reactions will be calculated for pin and frictionless roller in the case of a simply supported beams and encastred cantilever
- bending moment and shear force diagrams must be drawn correctly for both a simply supported beam and cantilever
- significant values that may be determined are positions of zero shear/maximum bending moment and contraflexure where appropriate

With regard to Outcome 2

- the assessment will involve either one loaded simply supported beam or one loaded cantilever
- loading conditions will be restricted to point loads
- the section used must be restricted to one of the following: simple rectangular, circular or 'i' section
- the relationships between the following parameters should be correctly applied with respect to simple bending theory: bending moment, bending stress, second moment of area about the neutral axis, centroid, distance from the neutral axis, modulus of elasticity, radius of curvature about the neutral axis

With regard to Outcome 3

- polar second moments of area should be correctly determined for one shaft of solid circular cross-section and one shaft of hollow circular cross-section
- the relationships between the following parameters should be correctly applied relating to simple torsion theory: torque, polar second moment of area, torsional stress, radius corresponding to torsional stress, modulus of rigidity, angle of twist and length of shaft

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 basic knowledge and understanding of Strength of Materials in an engineering context. On successful completion of the Unit candidates will be able to use shear force and bending moment diagrams to solve problems involving simply supported beams and cantilevers. They will have the knowledge and understanding to apply simple bending theory to idealised beams and will also be able to apply simple torsion theory to solve problems involving shafts of circular cross-sectional area.

In Outcome 1 candidates should learn to determine support reactions, shear stress and bending moment distributions for simply supported statically determinate beams and cantilevers. Following the initial calculation of reactions, the concepts of shear stress and bending moments should be introduced and that they vary along the beam or cantilever. Variations in shear stress and bending moment can be deduced for the simple loading conditions specified and from these shear stress and bending moment diagrams can be produced. These diagrams should be drawn so as to give a good representation of the distributions and to scale where necessary. The relationship between shear stress and bending moment can be explained in terms of diagram areas/slopes and significant points can be found. Understanding can be developed by a series of examples of increasing complexity, leading to the standard required for the outcome assessment.

In Outcome 2 the examination of beams and cantilevers should be extended to include simple bending theory. The parameters relevant to bending should be introduced, together with the relationships between them. This should lead naturally to the concept of second moment of area and to its calculation for regular, solid cross-sections. The use of charts as well as calculations should be encouraged. This theory can now be applied to beams and cantilevers under the specified loading conditions using a series of examples of increasing complexity. Determining the stress distribution across the cross-section at the point of maximum bending stress should be emphasised due to its importance in design calculations.

In Outcome 3 the concept of torque and torsional stress should initially be introduced followed by identification of the parameters relevant to simple torsional theory and the relationships between them. From the concept of polar second moment of area, its method of calculation can be shown for circular shafts, both solid and hollow cross-section. The use of charts as well as calculations should be encouraged. Simple torsional theory can now be applied to circular shafts, again of solid and hollow cross-section, using a series of graded examples. The calculation of torsional stress distributions across the section and of angle of twist along the length of the shaft should be emphasised.

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 and practical laboratory work. The Unit should be taught very much in an engineering context and as such relevant engineering examples should be used throughout Unit delivery.

While the majority of the Unit can be delivered in a classroom centres should allow candidates to undertake practical experiments so that they have opportunities to relate theory learnt in the classroom to practice.

The Internet contains a rich source of materials on bending and torsion theory. Wall charts, videos, DVDs illustrating different bending and torsion concepts and principles can also be very useful learning and teaching aids.

Industrial visits could help to develop a broader perspective of the subject.

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

The Using Number Core Skill component at SCQF level 5 may be developed in all three Outcomes while candidates perform calculations involving the application of bending and torsional theory to simply supported beams, cantilevers and shafts of circular cross-sectional area.

Candidates may have opportunities to develop the Using Graphical Information Core Skill component at SCQF level 5 in Outcome 1 while, for example, they are producing shear force and bending moment diagrams.

The Critical Thinking Core Skill component at SCQF level 5 may be developed in all three Outcomes while candidates solve problems involving bending and torsion theory.

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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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