

## SQA Advanced Unit specification

### General information for centres

**Unit title:** Statics and Strength of Materials

**Unit code:** HT71 47

**Unit purpose:** This Unit is designed to enable candidates to develop knowledge and understanding of the principles and laws that relate to statics and material strength.

On completion of the Unit the candidate should be able to:

- 1 Solve problems relating to static equilibrium.
- 2 Solve problems relating to compressive, tensile and shear loading on materials.

**Credit points and level:** 1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7\*)

*\*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 National 1 to Doctorates.*

**Recommended prior knowledge and skills:** Candidates should have knowledge and understanding of mathematics and/or physics. This may be evidenced by a Higher in Mathematics and/or Physics or a National Certificate in Engineering.

**Core skills:** There may be opportunities to gather evidence towards the following listed Core Skill components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Using Number	SCQF level 6
Critical Thinking	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.

**Assessment:** The assessment for both Outcomes in this Unit should be combined together into one assessment paper. This paper should be taken by candidates at one single assessment event that should last one and a half hours. Assessment should be conducted under controlled, supervised conditions. Candidates should be provided with a formula sheet and are permitted to use a scientific calculator, but not a programmable calculator, in the assessment.

**SQA Advanced Unit specification: statement of standards**

**Unit title:** Statics and Strength of Materials

**Unit code:** HT71 47

The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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**

Solve problems relating to static equilibrium

**Knowledge and/or skills**

- ◆ external reactions
- ◆ compressive and tensile forces in plane frames
- ◆ instability and redundancy
- ◆ compressive and tensile forces in practical engineering applications
- ◆ simply supported beams
- ◆ cantilever
- ◆ shear force diagrams
- ◆ bending moment diagrams
- ◆ magnitude and position of maximum bending stress (compressive and tensile)

**Evidence requirements**

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **seven from nine** knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of seven out of nine knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all seven items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

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- ◆ perform calculations using the equations of static equilibrium
- ◆ solve a framework problem using nodal analysis or methods of section
- ◆ solve a framework problem using vector analysis
- ◆ determine whether a framework is safe/unsafe
- ◆ identify redundant member/s
- ◆ draw shear force and bending moment diagrams for simply supported beams or cantilevers
- ◆ determine the position of maximum shear for simply supported beams or cantilevers
- ◆ determine the positions of maximum tensile and compressive bending for simply supported beams or cantilevers

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment.

Candidates will be permitted to use scientific calculators during the assessment.

### **Assessment guidelines**

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment of this Outcome should be combined with that for Outcome 2 to form a single assessment paper, details of which are given under Outcome 2.

## **Outcome 2**

Solve problems relating to compressive, tensile and shear loading on materials

### **Knowledge and/or skills**

- ◆ stress
- ◆ strain
- ◆ stress-strain relationship
- ◆ modulus of elasticity
- ◆ direct shear stress
- ◆ torsional shear stress
- ◆ single/multiple shear plane conditions
- ◆ neutral axis
- ◆ second moments of area
- ◆ parallel axis theorem
- ◆ polar moments of area
- ◆ bending equation
- ◆ torque equation
- ◆ beam selection

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### Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **ten out of fourteen** knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of ten out of fourteen knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all ten items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ calculate at least two stresses, cross-sectional areas and compressive/tensile forces (for either hollow rectangular/circular or "I" shaped cross sections)
- ◆ calculate the strain and change in length due to compressive and tensile loading
- ◆ determine the correct size and number of pins/bolts etc subjected to direct shear loading
- ◆ determine the correct size and number of pins/bolts/keys etc subjected to a torque
- ◆ calculate at least one neutral axis position for either "I", "T" or channel section
- ◆ determine at least one second moment of area value for either hollow rectangular, hollow circular, "I", "T" or channel section
- ◆ solve a problem using the bending equation
- ◆ calculate polar moments of area
- ◆ calculate shear stress in solid and hollow shafts being subjected to a torque
- ◆ solve a problem using the torque equation
- ◆ state the maximum deflection of a cantilever or a simple supported beam being subjected to both a point load and a UDL
- ◆ select the correct beam from a restricted list to support both point loads and UDL's

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed-book conditions and as such candidates should not be allowed to bring any textbooks, handouts, or notes to the assessment. Candidates will be permitted to use scientific calculators during the assessment.

The assessment of this Outcome should be combined with that of Outcome 1 to form one assessment paper for the Unit. This single assessment paper should be taken at a single assessment event lasting one and a half hours and carried out under supervised, controlled conditions. Candidates should be provided with a formula sheet and are permitted to use a scientific calculator, but not a programmable calculator, in the assessment.

### Assessment guidelines

The assessment paper may be composed of an appropriate balance of short answer, restricted response and structured questions.

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### Administrative Information

<b>Unit code:</b>	HT71 47
<b>Unit title:</b>	Statics and Strength of Materials
<b>Superclass category:</b>	XH
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#### History of changes:

Version	Description of change	Date

**Source:** SQA

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## **SQA Advanced Unit specification: support notes**

### **Unit title: Statics and Strength of Materials**

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 has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

- 1 the use of basic equilibrium concepts and theorems to static problems
- 2 the use of basic material strength concepts and theorems to solve compressive, tensile and shear load material problems

In designing this Unit the Unit writers have identified the range of topics they would expect to be covered by lecturers. The writers have also given recommendations as to how much time should be spent on each Outcome. This has been done to help lecturers to decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for a centre to use this list of topics it is strongly recommended that it does so to ensure continuity of teaching and learning across the Statics and Strength of Materials Unit and because the assessment exemplar pack for this Unit is based on the knowledge and/or skills and list of topics in each of the Outcomes.

The list of topics is given below. Lecturers are advised to study this list of topics in conjunction with the knowledge/skills section of this document and the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit.

#### **1 Solve problems relating to static equilibrium (17 hours)**

Stable and unstable framework identity

Consideration of real life static situations such as cranes, hoists, brackets etc

Frameworks supported at the base, from the side, from above or a combination of any

Shafts (beams) simply supported on bearings offset from the ends

Cantilevers and simply supported beam reactions including the beam mass as a uniformly distributed load

#### **2 Solve problems relating to compressive, tensile and shear loading on materials (23 hours)**

Deflection at this stage should be limited to the use of standard equations.

Areas of practical work for both Outcomes may include, but are not limited to, those covered within the Mechanical Engineering Principles Unit.

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### Guidance on the delivery and assessment of this Unit

Practical demonstration and realistic problem solving should support the application of static equilibrium and strength of material principles and concepts. Computer software should be made available where appropriate and candidates should be encouraged to take a logical problem solving approach throughout.

It should be noted that this Unit can be delivered on a free standing basis or combined with the Engineering Principles Unit for teaching and learning. Such flexibility may be important to a centre where, for example, both Units are included in a number of SQA Advanced Engineering courses.

The Unit has been written such that there is sufficient time built in for candidates to practise what they have learnt through appropriate formative assessment exercises. Additionally, the Unit has been designed to incorporate time for some experimental work and computer simulations (these will not be formally assessed in the Unit) so that candidates have an opportunity to confirm theories in practice. Whilst, it is recognised that computer simulation can be a valuable tool in confirming mechanical theories, it is nevertheless felt important that candidates do some practical laboratory work so that they can gain experience in using test equipment and analysing the results of experiments.

As this Unit provides core static and strength of materials principles which underpin much of the studies done in other areas of the SQA Advanced Certificate/Diploma in Mechanical Engineering it is recommended that the Unit be delivered towards the start of these awards.

Where this Unit is incorporated into other Group Awards it is recommended that it be delivered in the context of the specific occupational area(s) that the award is designed to cover.

Details on approaches to assessment are given under Evidence Requirements and Assessment guidelines under each Outcome in the SQA Advanced Unit specification: statement of standards section. It is recommended that these sections can be read carefully before proceeding with the assessment of candidates.

#### *Opportunities for developing Core Skills*

There may be opportunities to gather evidence towards the following listed Core Skill components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Using Number	SCQF level 6
Critical Thinking	SCQF level 6

### Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that the assessment, which is required to be at a single event, was conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* (SQA 2000).

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### **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](http://www.sqa.org.uk/assessmentarrangements).



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### **General information for candidates**

#### **Unit title:** Statics and Strength of Materials

This Unit has been designed to allow you to develop knowledge, understanding and skills in basic static and strength of materials concepts and theorems that underpin so much of more advanced studies in Mechanical Engineering. If you have studied these subjects before the early parts of this Unit it will provide you with an opportunity to revise the concepts and theorems you have learnt in previous courses.

The Unit will also provide you with an opportunity to study the ways in which a variety of methods such as nodal analysis, vector analysis and method of section can lead to the same results and that material properties are extremely important within design.

It is good to gain sound theoretical knowledge and understanding but it is also important that you are able to set your theoretical knowledge within a practical mechanical context. Thus, it is likely during the Unit that you will be provided with the opportunity to relate theory to practice by doing practical experiments and computer simulations on mechanical problems.

By the end of the Unit you will be expected to solve static and strength of material problems using the concepts and theorems you have learned. You will also be expected to sketch vector, shear force and bending moment diagrams.

The formal assessment for this Unit will consist of a single assessment paper lasting one and half-hours. The assessment will be conducted under closed-book conditions in which you will not be allowed to take notes, textbooks etc into the assessment. However, you will be allowed to use a scientific calculator. You will sit this assessment paper at the end of the Unit.

Candidates studying towards an SQA Advanced Certificate or SQA Advanced Diploma in Mechanical Engineering will also have to answer questions on this subject as part of the Graded Unit.