SQA Advanced Unit Specification

General information for centres

Unit title: Structural Mechanics

Unit code: HR3V 47

Unit purpose: This Unit is designed to provide candidates with a basic knowledge and understanding of structural mechanics, in order to solve problems relating to statically determinate beams and frames.

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

1 Evaluate loads on elements of structures and calculate support reactions.
2 Analyse problems relating to direct stress & strain.
3 Calculate shear forces, bending moments and deflections for statically determinate beams.
4 Analyse pin jointed frames using the method of sections and the method of joint resolution.

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: Access to this Unit is at the discretion of the centre. It is recommended that candidates have achieved Mathematics at Standard Grade Credit level.

Core Skills: There are opportunities to develop the Core Skills of Numeracy and IT in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

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:

It is possible to assess candidates either on an individual Outcome basis, a combination of Outcomes by a single holistic assessment combining all Outcomes. The assessment paper/s should be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be conducted under supervised, controlled conditions. A single assessment covering all Outcomes should not exceed 2 hours in duration. It should be noted that candidates must achieve all the minimum Evidence Requirements specified for each Outcome in order to pass this Unit.

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

An exemplar instrument of assessment and marking guidelines has been produced to provide examples of the type of evidence required to demonstrate achievement of the aims of this Unit and to indicate the national standard of achievement at SCQF level 7.

SQA Advanced Unit specification: statement of standards

Unit title: Structural Mechanics

Unit code: HR3V 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

Evaluate loads on elements of structures and calculate support reactions

Knowledge and/or skills

♦ Load paths through simple and multi-storey structures
♦ Uniformly distributed loads and point loads from given floor loadings
♦ Degrees of freedom relating the support conditions
♦ Equations of static equilibrium used to analyse simply supported and cantilevered beams

Evidence Requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

♦ evaluate uniformly distributed and point load(s) on simple beams within structures
♦ evaluate reactions on simply supported and/or cantilevered beams, with uniformly distributed and point load(s)

Evidence for the knowledge and/or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **two out of four** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to both, this must be provided by manual calculations.

Assessment guidelines

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open-book conditions.

Outcome 2

Analyse problems relating to direct stress & strain

Knowledge and/or skills

♦ Use of appropriate formulae to calculate direct stress
♦ Use of appropriate formulae to calculate direct strain
♦ Hooke's law demonstrating the relationship between stress and strain and the evaluation of Young's Modulus of Elasticity

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

♦ solve problems relating to direct stress & strain

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **two out of three** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to two items, this must be provided by manual calculations.

Assessment guidelines

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open-book conditions.

Outcome 3

Calculate shear forces, bending moments and deflections for statically determinate beams

Knowledge and/or skills

♦ Shear forces on simply supported and cantilevered beams
♦ Bending moments on simply supported and cantilevered beams
♦ Points of contraflecture
♦ Maximum deflection formula for statically determinate beams
♦ Analysis of statically determinate beams using computer software

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

♦ calculate shear forces, bending moments and deflections for statically determinate beams

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all three items, this must be provided by manual calculations.

Assessment guidelines

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open-book conditions.

Outcome 4

Analyse pin jointed frames using the method of sections and the method of joint resolution

Knowledge and/or skills

♦ Evaluation of the determinancy of a frame
♦ The equations of equilibrium are used to evaluate frame reaction components
♦ The method of Joint Resolution is used to analyse frames
♦ The method of Sections is used to analyse frames
♦ Analysis of pin jointed frames using computer software

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

♦ analyse and evaluate pin jointed frames using the method of sections and the method of joint resolution

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to three items, this must be provided by manual calculations.

Assessment guidelines

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open-book conditions.

Administrative Information

Unit code: HR3V 47

Unit title: Structural Mechanics

Superclass category: TM

Date of publication: August 2017

Version: 01

Source: SQA

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit specification: support notes

Unit title: Structural Mechanics

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   Evaluate loads on elements of structures and calculate support reactions.
2   Analyse problems relating to direct stress & strain.
3   Calculate shear forces, bending moments and deflections for statically determinate beams.
4   Analyse pin jointed frames using the method of sections and the method of joint resolution.

This Unit is at SCQF level 7 and has been developed as part of the new SQA Advanced Certificate and SQA Advanced Diploma in Built Environment and Civil Engineering awards.

Throughout the Unit emphasis will be placed where appropriate on the application of Health & Safety and Sustainability. Safe working practises should be looked at in accordance with current safety codes of practise and regulations. Sustainability should include reference to criteria affecting sustainability, impact of not implementing sustainability on the environment and the legislation promoting sustainability.

In designing this Unit, the Unit writer has identified the range of topics would be expected to be covered by lecturers. While it is not mandatory for a centre to use this list of topics it is strongly recommended that it does so.

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

1   Evaluate loads on elements of structures and calculate support reactions. (8 hours)

Load Paths: Grids. Loads at different floor levels. Load paths from floors to beams to columns to founds to ground.

Loads: Concentrated point load and uniformly distributed loads. Densities of standard building materials; calculation of floor loadings; Calculation of uniformly distributed loads and point loads on simple beams. Calculation of total loads on beams and columns from total floor loadings.

Beam Types: Cantilever, simply supported and simply supported with overhang. Support conditions: Pinned, Roller and Fixed.

Analysis: Equations of static equilibrium: $\Sigma V = 0$, $\Sigma H = 0$ and $\Sigma M = 0$. Analysis of beams, using manual calculation.

2   Calculate shear forces, bending moments and deflections for simple beams. (12 hours)

Shear Forces: Explanation of Shear Force. Sign convention for construction of shear force diagrams. Sketch shear force diagrams for various beam types: cantilever, simply supported and simply supported with overhang using a variety of concentrated loads and uniformly distributed loads. Use of standard formulae for maximum shear force

Bending Moments: Explanation of bending moments: forces acting through a point give zero bending moment, maximum bending moment at point of zero shear. Sign convention for construction of bending moment diagram. Calculation of bending moments at critical points on beams: area of shear force diagram, calculation. Sketch bending moment diagram for various beam types and loadings. Use of standard formulae for maximum bending moments

Points of Contraflecture: Calculation of location of point of contraflecture (Bending moment = 0).

Deflections: Use of standard formulae for maximum deflections for standard loadings, uniformly distributed load over full length, point load at mid-span. Derivation of at least one standard deflection formula.

Computer Software: Analysis of beams, using manual calculation and computer software

3   Analyse pin jointed frames using the method of sections and the method of joint resolution. (13 hours)

Determinancy: Frame determinancy: number of constraints; number of joints, number of members. Forces acting only along axis of members.

Reactions: Use the three equations of statics, $\Sigma V = 0$, $\Sigma H = 0$ and $\Sigma M = 0$

Joint resolution: Method of joint resolution: resolve inclined forces in horizontal and vertical components, use of $\Sigma V = 0$, $\Sigma H = 0$ to calculate joint forces.

Method of sections: Method of sections: cut section of frame, $\Sigma M = 0$ i.e. no rotation of section, apply $\Sigma M = 0$ about various points to solve for unknown forces.

Computer software: Analysis of frames using manual calculations and computer software.

4   Analyse problems relating to direct stress & strain and Young's Modulus. (7 hours)

Stress: Definition of direct stress: axial loads, area, compression, tension

Strain: Explanation of strain: Hooke's Law, Young's Modulus for different materials

Hookes Law: Apply Hooke's Law: calculate direct strain/stress, elongation

Guidance on the delivery and assessment of this Unit

Where available, evidence from the workplace can also be incorporated to enhance the learning Outcomes, provided that this evidence is appropriate and authenticated as the student's own work.

It is recommended that evidence for learning Outcomes is achieved through well-planned course work, assignments and projects. Assessment may be formative and summative and both may feature as part of the process. Although assessments must be focused on the individual achievement of each student, group work and role-play activities may contribute to the assessment. Integrative assignments and project work will help to link this Unit with other related Units.

The volume of evidence required for each assessment should take into account the overall number of assessments being contemplated within this Unit and the design of the overall teaching programme.

Opportunities for developing Core Skills

Opportunities for the development of Core Skills at the output level are more fully identified in the Core Skills Sign Posting Guide. The grid below is indicative of the opportunities for Core Skills development within this Unit.

Core Skill	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
1 Communication					
Reading					
Writing					
Oral					
2 Numeracy					
Using Number	3	3	3	3	
Using Graphical Information					
3 IT					
Using Information Technology		3	3		
4 Problem Solving					
Critical Thinking					
Planning and Organising					
Reviewing and Evaluating					
5 Working with Others					

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. Arrangement would be required to be put in place to ensure that the assessment, which is required to be as two events, was conducted under controlled, supervised conditions.

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

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.

General information for candidates

Unit title: Structural Mechanics

This Unit has been designed to allow you to develop knowledge, understanding and skills in:

♦   evaluating loads on elements of structures and calculating support reactions
♦   analysing problems relating to direct stress & strain
♦   calculating and sketching shear force and bending moment diagrams for statically determinate beams
♦   analysing pin jointed frames using the method of sections and the method of joint resolution

Assessments will generally involve manual calculation exercises.