Higher National Unit specification

General information

Unit title: CAD: Analysis (SCQF level 8)

Unit code: F215 35

Superclass: TM

Publication date: February 2008

Source: Scottish Qualifications Authority

Version: 03 (July 2016)

Unit purpose

This Unit is designed to provide learners with advanced knowledge and skills which will allow them to develop a systematic approach to the analysis and design of structural members. This Unit would be useful for learners who may go on to be employed in Engineering and Architectural disciplines.

Outcomes

On successful completion of the Unit the learner will be able to:

1 Calculate the effect of loading on individual structural members.
2 Create and use a spreadsheet to automatically calculate the effect of loading on individual structural members.
3 Analyse the effect of loading on a CAD model within a Finite Element Analysis application.
4 Design a structural member.

Credit points and level

1 Higher National Unit credit at SCQF level 8: (8 SCQF credit points at SCQF level 8)

Recommended entry to the Unit

It would be an advantage for learners to have a basic knowledge and understanding of mathematics. This may be evidenced by possession of an appropriate Higher or National Unit or equivalent level of study.

Higher National Unit specification: General information (cont)

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Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

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

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.

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**.

Higher National Unit specification: Statement of standards

Unit title: CAD: Analysis (SCQF level 8)

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

Calculate the effect of loading on individual structural members.

Knowledge and/or Skills

- Calculation and permissible deflection
- Constraints
- Loads
- Factor of safety
- Mathematical formulae

Outcome 2

Create and use a spreadsheet to automatically calculate the effect of loading on individual structural members.

Knowledge and/or Skills

- Spreadsheet design
- Formulae
- Printing data
- Printing formulae

Outcome 3

Analyse the effect of loading on a CAD model within a Finite Element Analysis application.

Knowledge and/or Skills

- Material properties
- Deflection
- Material stress
- Constraints
- Load
- Safety factor
- Verification of input and output
- Animation

Higher National Unit specification: Statement of standards (cont)

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Outcome 4

Design a structural member.

Knowledge and/or Skills

- Deflection
- Load
- Span
- Safety factor
- Cost engineering
- Section properties

Evidence Requirements for this Unit

Outcome 1

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- manually calculate the effect of loading on individual structural members.

Evidence must contain details of mathematical formula(e) used to calculate deflection point and deformation, loading and calculation of appropriate margins to establish factor of safety. Learners should be allowed to refer to relevant course material and mathematical formulae.

Outcome 2

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- develop formulae to automatically calculate loading.
- create and use a spreadsheet program to automatically calculate the effect of loading on individual structural members.
- produce a hard copy printout of a spreadsheet displaying the correct values and displaying the formulae used.

Learners should be allowed to refer to relevant course material and mathematical formulae.

Higher National Unit specification: Statement of standards (cont)

Unit title: CAD: Analysis (SCQF level 8)

Outcome 3

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- analyse the effect of loading on a CAD model within a Finite Element Analysis package. This should include evidence of how the type of constraint available within the application and the loading factor can alter the stress levels acting on the member.
- produce a hard copy printout visually demonstrating the effect of loading on a structural member.

Learners should be allowed to refer to relevant course material and mathematical formulae.

Outcome 4

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- design a structural member for a given brief.
- produce a CAD drawing of the structural member.

Evidence must include a rationale for choice of method for specifying and analysing the structural member and include reference to span, load, height limitations, safety factor and cost engineering information.

Learners should be allowed to refer to relevant course material and mathematical formulae.

Higher National Unit Support Notes

Unit title: CAD: Analysis (SCQF level 8)

Unit Support Notes are offered as guidance and 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 is at SCQF level 8 and has been devised as an optional Unit within the new HND Computer Aided Draughting and Design award. However, this does not preclude the use of the Unit in other awards where award designers feel this to be appropriate.

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

- calculating the effect of loading on individual structural members
- creating and using a spreadsheet to automatically calculate the effect of loading on individual structural members
- analysing the effect of loading on a CAD model within a Finite Element Analysis package
- designing a structural member

In designing this Unit, a range of topics have been identified that would be expected to be covered by lecturers to help lecturers decide what depth of treatment should be given to the topics attached to each of the Outcomes. A list of topics for each Outcome is given below. Lectures are advised to study this list in conjunction with the Evidence Requirements for each Outcome.

Guidance on approaches to delivery of this Unit

Outcome 1

Calculate the effect of loading on individual structural members.

It is recommended that the structural member specified in Outcome 1 should be taken forward with the properties being used in the formulae in the spreadsheet for Outcome 2. The same structural member should be used in Outcome 3, using section tables to obtain the dimensions of the member. This could be in the form of (however not limited to) a steel/timber beam supporting a concrete floor slab, or a bar from weight-lifting equipment.

Higher National Unit Support Notes (cont)

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This Outcome is designed to introduce learners to the behaviour of structural members under certain loading conditions. Various combinations of loads and constraints could be utilised to affect the member. Examples should make use of various loads and constraints on the same member, and also the same loading conditions on members with varying section properties. Learners should be provided with examples of where areas of tension and compression exist within members.

The learners should be introduced to rough sizing of members through commonly used span to depth ratios, eg span divided by 20 results in a rough depth of a beam. The resultant member properties should be subjected to manual calculation methods to determine the bending moment. final calculations should make use of appropriate factors of safety.

At all times, the learners should be aware of the terms and symbols used in the general expression of simple bending.

Outcome 2

Create and use a spreadsheet to automatically calculate the effect of loading on individual structural members.

This Outcome is designed to introduce learners to an automated method used to calculate the effect of leading on structural members. Learners should be shown how to create and use worksheets using good practice at all times, eg adding cell references, commenting or explanatory notes and making use of formatting for ease of use.

The formulae used in Outcome 1 should be entered into the spreadsheet with the properties of the member and loading to verify the bending moment value arrived at for the Outcome. Charts should be use to visually display the effect of loading, taking the values directly from the worksheet.

Learners should be aware of the various print options, eg print cell values, print formulae, selection and chart.

Outcome 3

Analyse the effect of loading on a CAD model within a Finite Element Analysis package.

Learners should be introduced to the properties required by the Finite Element Analysis package as well as their definitions.

- Yield strength
- Possion's Ratio
- Young's Modulus
- Density

The learner should be provided with worked examples detailing various constraints and loading methods before simulating the deformation and stress on the member used for Outcomes 1 and 2. The stress and deformation should be investigated visually using both still and animated results.

As with the previous Outcomes, the loading, constraint and section properties should be varied to highlight how the structural member may be affected.

The learner should provide an explanation of one method they might employ to verify the output from the analysis application.

Outcome 4

Design a structural member

Learners should give an overview of various methods used to specify and analyse structural members, detailing some of the advantages and limitations to each method. Learners should employ one of the methods used in this Unit to design a member to meet a given brief. This brief should include reference to span, load or height limitations etc. Learners should also be aware of cost implications and where appropriate, a substitute offered.

Marks should be awarded for workings shown where correct. This should allow the learner to achieve a pass grade in an individual Outcome where minor calculation errors have occurred and an incorrect final value submitted but the majority of the calculation is shown to be technically correct. A guide to assessment loading is provided below.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

All assessments for this Unit could be undertaken as open-book tasks. All assessments could be stand-alone tasks if required. However if a case study approach were used, it would also be possible to integrate assessments for Outcomes 1, 2 and 3. Outcome 4 is assessed as stand-alone. It is recommended that the structural member information specified in Outcome 1 could be taken forward with the properties being used in the formulae in the spreadsheet for Outcome 2. This same structural member information could be used in Outcome 3, with section tables used to calculate the dimensions of the member. This could be in the form of, however not limited to, a steel/timber beam supporting a concrete floor slab or a bar from weight lifting equipment.

Assessment Guidelines

Outcome 1

The assessment for this Outcome could be carried out as a separate event lasting no more than one hour. It could also be combined with Outcomes 2 and 3 as part of a single integrated open-book assessment lasting no more than three hours.

Higher National Unit Support Notes (cont)

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It is recommended that the structural member information required for this Outcome could be taken forward with the properties being used in the calculation performed within the spreadsheet for Outcome 2. The same structural member information could also then be used in Outcome 3 where section tables will be used to calculate the dimensions of the member. This could be in the form of, however not limited to, a steel/timber beam supporting a concrete floor slab or a bar from weight lifting equipment.

Outcome 2

The assessment for this Outcome could be carried out as a separate event lasting no more than one hour.

It could also be combined with Outcomes 1 and 3 as part of a single integrated open-book assessment lasting no more than three hours.

It is recommended that the structural member information required for this Outcome could be brought forward from Outcome 1 with the properties being used in the formulae and subsequent calculation for the spreadsheet for this Outcome. The same structural member information could also then be used in Outcome 3 where section tables will be used to calculate the dimensions of the member. This could be in the form of, however not limited to, a steel/timber beam supporting a concrete floor slab or a bar from weight lifting equipment.

Outcome 3

The assessment for this Outcome could be carried out as a separate event lasting no more than one hour. It could also be combined with Outcomes 1 and 2 as part of a single integrated open-book assessment lasting no more than three hours.

It is recommended that the structural member information required for this Outcome could be brought forward from Outcomes 1 and 2 with these properties being used in the calculations and subsequent analysis for this Outcome. The same structural member information could then be imported and section tables used to calculate the dimensions of the member. This could be in the form of, however not limited to, a steel/timber beam supporting a concrete floor slab or a bar from weight lifting equipment.

Outcome 4

The assessment for this Outcome should be carried out as a single event lasting no more than four hours.

Opportunities for 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 social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Higher National Unit Support Notes (cont)

Unit title: CAD: Analysis (SCQF level 8)

Opportunities for developing Core and other essential skills

There may be opportunities to gather evidence towards Core Skills of *Numeracy, ICT* and *Problem Solving* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

The use of number/formulae to calculate parameters critical to the design, planning and specification detail — the stressing of material to arrive at safety tolerances and the cost effectiveness of producing designs — all give ample opportunities to develop the Core Skills of *Numeracy* and *ICT*. Planning, critical appraisal, review and evaluation are intrinsic to this process also, thus developing the Core Skill of *Problem Solving*.

History of changes to Unit

Version	Description of change	Date
03	No change to context. Some minor changes to correct errors/typos and transferred to the current template.	06/07/16
02	Superclass changed from VF to TM.	26/06/13

General information for learners

Unit title: CAD: Analysis (SCQF level 8)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit is at SCQF level 8 and has been devised as an optional Unit within the new HND Computer Aided Draughting and Design award.

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

1 Calculating the effect of loading on individual structural members.
2 Creating and using a spreadsheet to automatically calculate the effect of loading on individual structural members.
3 Analysing the effect of loading on a CAD model within a Finite Element Analysis package.
4 Designing a structural member.

This Unit will also allow you to develop practical skills that will enable you to analyse, design and evaluate structural members.

You will be encouraged to use every opportunity to gain as much 'hands on' experience as possible. Each learner ideally should have open access to a PC with the CAD software installed.

There may be opportunities to gather evidence towards Core Skills of *Numeracy, ICT* and *Problem Solving* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components. The use of number/formulae to calculate parameters critical to the design, planning and specification detail — the stressing of material to arrive at safety tolerances and the cost effectiveness of producing designs — all give you ample opportunities to develop the Core Skills of *Numeracy* and *ICT*. Planning, critical appraisal, review and evaluation are intrinsic to this process also, thus developing your Core Skill of *Problem Solving*.

You will be allowed access to all course notes during the assessment event.

At the discretion of the individual centres, assessment of all Outcomes can be carried out after the teaching of the appropriate topics or as an integrated assignment, this will not usually be attempted until all teaching has been completed.