National Unit Specification: general information

UNIT Construction Calculations (SCQF level 5)

CODE F3JL 11

SUMMARY

This Unit is suitable for candidates who aspire to a career in the Construction Industry or related fields as a technician or technologist.

The aim of this Unit is to provide the candidate with a range of underpinning mathematical skills. Although mathematical skills are being assessed it should be emphasised that they are being used in practical construction applications and contexts. Mathematics is the tool; construction is the concept. The candidate will learn how to use mathematical concepts previously learned and apply them to the topics with in the area of the Built Environment such as structural mechanics, land surveying and materials testing and Civil Engineering. Key skills developed by the candidate in this Unit will also include the extraction of data from standard tables and the transposition of construction formulae.

OUTCOMES

1 Demonstrate the use of Pythagoras' Theorem, sine and cosine rules applied to construction calculations.
2 Transposition of formulae used in construction.
3 Construct appropriate forms of graphs.

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 General level

Administrative Information

Superclass: RB

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CREDIT VALUE

1 credit at Intermediate 2 (6 SCQF credit points at SCQF level 5*).

**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 or Core Skill components in this Unit. Opportunities for developing aspects of Core Skills are highlighted in *Guidance on Learning and Teaching Approaches.*

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

Demonstrate the use of Pythagoras' Theorem, sine and cosine rules applied to construction calculations.

Performance Criteria

(a) Solve calculations using Pythagoras' theorem relating to applications in the construction industry.
(b) Calculate unknown length of sides/angles in a triangle using the sine and cosine rules.

OUTCOME 2

Transposition of formulae used in construction.

Performance Criteria

(a) Extract information from standard tables used by civil engineers and building technicians.
(b) Solve problems by applying consistent units and powers.
(c) Apply appropriate units to construction formulae.
(d) Solve problems by transposing formulae, substituting numerical values and providing the appropriate units to the answers.

OUTCOME 3

Construct appropriate forms of graphs.

Performance Criteria

(a) Construct best-fit straight line graphs from experimental data.
(b) Extract and interpolate information from straight line graphs.
(c) Select an appropriate form of graph for the representation of given tabulated data.
(d) Plot graphs from given tables of data.

EVIDENCE REQUIREMENTS FOR THIS UNIT

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

Written and/or recorded oral evidence is required to demonstrate that the candidate has achieved this Unit to the standard specified in the Outcomes and Performance Criteria. The evidence for this Unit should be obtained under controlled**,** supervised conditions. The assessment will be closed-book and should last no more than two hours

National Unit Specification: statement of standards (cont)

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Evidence will be gathered at appropriate points throughout the delivery of the Unit. Assessment must be manageable and practicable for centres.

Sampling within a performance criteria range is acceptable; a different sample must be used on each assessment occasion. The assessment paper/s should be composed of an appropriate calculations, use of formulae and preparation of graphs.

Typical forms of assessment may involve:

Outcome 1

Two questions one using Pythagoras' Theorem the other involving the use of either the sine or cosine rules.

Pythagoras' Theorem

The candidates may be given the horizontal and vertical components of a force(s) in a system and determine the resultant or equilibrium force by calculating its magnitude and direction.
Alternatively the candidates could be given information from a linear survey involving partial easting(s) and partial northing(s) and hence calculate the length of a line and it's angle from a survey reference point.

Sine/Cosine rules

The candidates could be given information from two survey stations and using either the sine or cosine rules determine the coordinates of a station or a reference direction of a line.
Alternatively the candidates solve triangle of forces by mathematical methods.

Outcome 2

The candidates may be given a standard formula used in construction, the formula must be transposed and data required in its use is extracted from standard tables before solving the unknown. The formula used must involve terms with a variety of units .For example using the standard formula for the maximum deflection of a simply supported steel beam carrying a uniformly distributed load over the entire span $\Delta = 5wL^4/384EI$ requires the candidate to evaluate the formula when the units expected for the individual terms are in mm, kN/m, N/mm^2 and cm^4 hence requiring the candidate to apply consistent units to the formula.

This can be assessed either by a single question or by two questions. One, the transposition of a formula and its subsequent solution. The other extracting of data from standard tables and the inclusion of it into a formula for solution.

Outcome 3

The candidate may be given two sets of data. One set will involve the construction of a pie chart, histogram or ogive curve. The other set will require the candidates to construct a 'best-fit' graph and extraction of a value.

National Unit Specification: statement of standards (cont)

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Questions need not be of equal weighting**.**

The Assessment Support Pack for this Unit provides appropriate sample assessment materials. Where centres wish to develop their own assessment materials they should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

UNIT Construction Calculations (SCQF level 5)

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 is an optional Unit in the National Certificate in Civil Engineering and Built Environment at SCQF level 6 and may be taken as a freestanding Unit.

This Unit is intended to introduce the candidate to the mathematical skills required by Civil Engineering and Building Technicians. The Unit should allow the candidate to develop previously learned skills and transfer them into a civil engineering or building context. Emphasis should be placed on the rounding of numbers in answers, significant figures and the application of units.

Outcome 1 requires the candidate to recognise application of Pythagoras' theorem, the sine and cosine rules to practical construction problems. Possible applications could include:

- given the magnitude and direction of a force(s) determine the magnitude and direction of the horizontal and vertical components of the force
- give a series of horizontal and vertical components of force determine the magnitude and direction of the resultant force
- given the length and bearing of survey line determine the partial northing and the partial easting of the line
- given the partial northing and the partial easting of a survey point determine the distance and angle to the point from a survey reference point
- given the northings and eastings of survey points determine the length of a line and horizontal angle
- given reference information for two survey stations and horizontal distance and angular measurements determine the coordinates of a station and/or reference direction of lines

This list should be taken as indicative and is not extensive.

Outcome 2 requires the candidate to recognise the need for consistency of units in a formula and is basically an introduction to numerical analysis. The candidate should be able to extract information from standard tables and evaluate formula and apply correct units to the answers.

Possible applications could include:

- extract data from the Structural Steel Section tables in mm, cm2, cm3 and cm4 as appropriate, apply the data to formula requiring the output units to be kN, kNm, kN/m2 (kPa) or N/mm2 (MPa) etc
- calculate the area, elastic modulus, plastic modulus, second moment of area about the centroid of regular shapes, use the calculated values to determine magnitudes of loads, moments, deflections etc
- transpose the general bending expression, standard formulae for determining bending moments, deflection formulae etc substitute values and state answers in appropriate units

- transpose formulae relating to the density, volume and mass of soils substitute values and state answers in appropriate units

This list should be taken as indicative and is not extensive.

Outcome 3 requires the candidate to recognise the need for graphs in the construction industry, the presentation of data to non-technical people and the application of graphs in the area of materials testing.

Possible applications could include:

- given data on the make up of traffic volumes the candidate produces pie-charts or histograms to indicate the order of magnitude of traffic types
- given the breakdown percentage costs for the costs for the construction of multi-storey steel frames the candidates presents the information graphically
- given the stress and strain results for a tensile test on a steel sample the candidate plots the points, constructs the 'best-fit' straight line, determines the slope of the line (and hence states the Young's Modulus or Modulus of Elasticity of the sample)
- given the results from a penetration test on a soil sample the candidate plots the points, constructs the 'best fit' straight line and obtains the liquid limit of the sample by projecting horizontally and vertically to and from the straight line

This list should be taken as indicative and is not extensive.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is important that the delivery of this Unit is related to practical civil engineering or building problems which the candidate will meet in subsequent Units. As part of the Course candidates should be told the relevance of the problems undertaken and in which Units they will be expected to use the transferable skills learned in this Unit. The main aim of this Unit should be to enable candidates relate the principles learned to other Units and to help then gain an appreciation of the need for mathematical skills in the construction industry. Every opportunity should be taken to revise and consolidate prior knowledge. The correct use of scientific calculators should be demonstrated and encouraged where appropriate.

Outcome 1

The mathematical concepts of Pythagoras' Theorem should be related to the areas of structural mechanics and land surveying this may be introduced by:
Forces as vector quantities processing magnitude, direction and point of application and as such can be reduced to horizontal and vertical components using the sine and cosine.
The net force acting on a system can be found using $\Sigma H=0$ and $\Sigma V=0$ and the concept of sine and cosine and the resultant or equilibrant force can be found using Pythagoras' Theorem.
Eastings and Northings as used in land surveying are an application of Cartesian coordinates and as such can be used to find lengths, angles or coordinates of points using either the sine or cosine rules.

National Unit Specification: support notes (cont)

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Outcome 2

Typical formulae that may be introduced to the candidates may include:

- the bending expression in it variety of forms ie f=My/I, f=M/Z, R=EI/M etc
- standard deflection formulae, $\Delta = 5wL4/384EI$, $\Delta = WL3/48EI$, $\Delta = wL4/8EI$, $\Delta = WL3/3EI$
- Second moment of area, $I = bd3/12$, $I = \pi D4/64$
- soil properties using $\rho = M/V$ in its various forms

Candidates should evaluate formulae this may involve transposition of the formula, extracting information form standard tables and applying consistent units.

Outcome 3

The use of graphs in the construction industry:
Pie charts, histograms and ogive curves used in traffic engineering to show the make up of traffic volumes, speed distribution, growth in traffic volumes, 15^{th} percentile, 50^{th} percentile and 85^{th} percentile speeds.
Pie charts and histograms used to illustrate: the breakdown in costs such as monthly expenditure of a contract; the relative costs of manufacture, fabrication, erection, painting and fire protection of a structural steelwork frame. Similar arrangements for reinforced concrete, masonry and timber structures can be developed.
The use of best-fit straight line graphs to the area of materials testing such as tensile testing of samples in determining Young's modulus, the plotting of values penetration against moisture content to obtain the liquid limit of a sample.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

In this Unit candidates will be:

- completing calculations
- completing sketches

These offer opportunities to develop aspects of the Core Skills of:

- *Numeracy*
- *Problem Solving*

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 communications 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.

National Unit Specification: support notes (cont)

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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).*

Achievement of this Unit requires the performance criteria for each Outcome to be met. A candidate who does not initially achieve the specified standard can have a further opportunity, attempting only the Outcome(s) not previously achieved.
Candidates should achieve a satisfactory mark of 60% in closed-book tests.

Typical forms of assessment may involve:

Outcome 1 — Two questions, one an application of Pythagoras' Theorem, sine and cosine the other using either the sine or cosine rules

Outcome 2 — Two questions, one the transposition of a formula and its subsequent solution, the other extracting of data from standard tables and the inclusion into a formula for solution.

Outcome 3 — Two questions, one the construction of a pie chart, histogram or ogive curve from given data, the other involving the construction of a best-fit graph form given data an the extraction of a value.

All questions need not be of equal weighting.

CANDIDATES WITH DISABILITIES AND/OR ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* **(www.sqa.org.uk)**.