

National Unit Specification: general information

UNIT Structures and Materials (Higher)

NUMBER D190 12

COURSE Technological Studies (Higher)

SUMMARY

This unit is designed to enable candidates to apply the principles of static equilibrium to structural systems and calculate the effect of loading on individual members.

OUTCOMES

- 1 Apply the conditions of static equilibrium in solving problems on concurrent force and non-concurrent force systems.
- 2 Apply the conditions of static equilibrium in solving problems on simple framed structure systems.
- 3 Use and interpret data from a tensile test in studying properties of materials.
- 4 Produce a specification for a structural component.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates will normally be expected to have attained one of the following:

- Standard Grade Technological Studies at grade 1 or 2
- Technological Studies Intermediate 2 or equivalent NC units

CREDIT VALUE

0.5 credit at Higher.

Administrative Information

Superclass: RC

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National Unit Specification: general information (cont)

UNIT Structures and Materials (Higher)

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit None

Core skills components for the unit Using Graphical Information H

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Structures and Materials (Higher)

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 the Scottish Qualifications Authority.

OUTCOME 1

Apply the conditions of static equilibrium in solving problems on concurrent force and non-concurrent force systems.

Performance criteria

- (a) The conditions of static equilibrium are applied correctly to co-planar force systems.
- (b) Force systems are represented correctly using free-body diagrams.
- (c) Forces are resolved correctly into horizontal and vertical components.
- (d) The principle of moments is applied correctly.
- (e) Analytical solutions to force system problems are correct.

Evidence requirements

Written and graphical evidence for PCs (a) to (e), including solutions to problems on concurrent and non-concurrent force systems.

OUTCOME 2

Apply the conditions of static equilibrium in solving problems on simple framed structure systems.

Performance criteria

- (a) The conditions of static equilibrium are applied correctly to framed structures.
- (b) Calculations to determine the magnitude and direction of support reactions are carried out correctly.
- (c) The nodal analysis method of solving simple framed structure problems is applied correctly.
- (d) The magnitude and nature of forces in frame members are evaluated correctly.

Evidence requirements

Written and graphical evidence for PCs (a) to (d).

National Unit Specification: statement of standards (cont)

UNIT Structures and Materials (Higher)

OUTCOME 3

Use and interpret data from a tensile test in studying properties of materials.

Performance criteria

- (a) Using data from a tensile test, a load-extension graph is plotted correctly, to appropriate scales.
- (b) The effects of progressive loading on a test piece are described clearly.
- (c) Calculations to determine Young's Modulus, yield stress and ultimate stress for a test piece are carried out correctly.
- (d) Characteristics of a stress/strain graph are stated clearly.
- (e) The properties of a material are interpreted correctly from the test data.

Evidence requirements

Written and graphical evidence for PCs (a) to (e).

OUTCOME 4

Produce a specification for a structural component.

Performance criteria

- (a) The design criteria for a component are interpreted correctly.
- (b) Tabulated and graphical data are used correctly in selecting a material for a component.
- (c) Calculations to determine a specification for a component are applied correctly.
- (d) The effects of the operational environment on a structural component are stated clearly.

Evidence requirements

Written and graphical evidence for PCs (a) to (d).

National Unit Specification: support notes

UNIT Structures and Materials (Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the time allocated to this unit is at the discretion of the centre, the notional design length is 20 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

Guidance for each outcome is listed below.

- Outcome 1 Coplanar force systems – conditions for static equilibrium.
- Resolution of inclined forces into horizontal and vertical components.
- Use of free body diagrams to represent force systems.
- Analytical solutions to problems on force systems. (No graphical solutions in tests and examinations.)
- Principle of moments; moments problems with inclined forces; hinge and roller reactions; simple beam problems, finding unknown forces and reactions; overall conditions for static equilibrium:
 $\Sigma F_h = 0, \Sigma F_v = 0, \Sigma M = 0$
- Practical applications of statics.
- Mass, weight and force; force of gravity on $1\text{kg} = 9.81\text{N}$ or $g = 9.81\text{m/s}^2$.
- Outcome 2 Introduction to framed structures; nodal analysis only; members in compression/tension; redundant members; hinge and roller reactions; (analytical methods only in tests and examinations.)
- Outcome 3 Common properties of materials – elasticity, ductility, plasticity, hardness, brittleness; common engineering materials – ferrous/non ferrous metals, thermoplastic and thermosetting plastics.
- Elastic and plastic behaviour of materials; common applications in engineering design.
- Behaviour of material under load; typical graphs for a tensile test.
- Direct stress, direct strain and Young's Modulus; use of Young's Modulus and ultimate stress values from the data booklet.
- Load/extension graphs and stress/strain graphs for mild steel, copper, aluminium and cast iron. Comparison of UTS, ductility and Young's Modulus.
- Outcome 4 Factor of safety – based on safe working stress and ultimate stress (or loads) – reasons for factor of safety.

National Unit Specification: support notes (cont)

UNIT Structures and Materials (Higher)

Although candidates may have been introduced to the concept of static equilibrium, the depth of treatment at this stage should be qualitative. The purpose of this unit at Higher level is to establish a clear understanding of the concept of equilibrium and its application in solving problems involving concurrent and non-concurrent force systems.

In framed structures and structural components, candidates should consider the effects of both external and internal forces acting on a body. Knowledge about tensile testing is required, as well as the use of related data. Calculations and the use of graphical and tabulated data are applied to establish a specification for a structural component.

Candidates should be able to understand and apply basic equilibrium conditions in the analysis of a force system and be able to use materials data and calculations in designing a structural component.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Every opportunity should be taken to ensure that the learning and teaching contexts are of an industrial nature and are seen as relevant by the candidate. An essential aspect of Structures and Materials is materials testing. Opportunities should be taken to relate content, where possible, to other units of the course. This can be achieved by incorporating structural loading, strain gauges, signal conditioning, data-logging and, perhaps, active control systems into an assignment.

In connection with the Case Study Report, teachers should take the opportunity to discuss and consider the impact of the advances in structures and materials on the economy, the environment and society. Candidates should be encouraged to consult periodicals, magazines, quality newspapers and audio-visual material to gain background knowledge in this area.

In presenting courses, teachers and lecturers should ensure that there is a balance between direct teaching and candidate-centred activities.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Each outcome of this unit must be assessed by a written test. This test should be closed book with the teacher in attendance to ensure examination conditions within the classroom. Candidates should be allowed to use the data booklet.

In order to gain success in the written test for an outcome, the candidate must achieve at least the cut-off score for that outcome. In addition, each candidate has to plot a graph from test data.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).