National Unit Specification: general information

UNIT: Mechanical Engineering Principles (SCQF level 6)

CODE F6X7 12

SUMMARY

This Unit may form part of a National Qualification Group Award or may be offered as a stand-alone Unit.

This Unit is designed to allow candidates to develop knowledge and understanding of the fundamental mechanical principles of engineering systems for a wide range of common applications.
The Unit will introduce candidates to the fundamental mechanical engineering concepts and their principles of applications which will form the foundation of their knowledge to progress to higher level studies in engineering and their subsequent engineering career.

The Unit is devised to further develop some of the concepts introduced in the Unit *Mechanical Engineering Principles* at SCQF level 5, with the focus being on an engineering systems approach.

The Unit is particularly suitable for those candidates training to be mechanical, manufacturing, process or system engineering technicians.

OUTCOMES

1 Solve problems of static equilibrium for fundamental mechanical elements of engineering systems.
2 Apply Newton's laws of motion to solve fundamental linear and angular motion problems for engineering systems.
3 Analyse the relationships between input and output of fundamental mechanical engineering systems.

Administrative Information

Superclass: XH

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National Unit Specification: general information (cont)

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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:

- SQA Unit *Mechanical Engineering Principles* at SCQF level 5
- Standard Grade Physics at Credit level
- Standard Grade Technological Studies at Credit level
- Standard Grade Mathematics at Credit level

CREDIT VALUE

1 credit at SCQF level 6 (6 SCQF credit points at SCQF level 6).

**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 in this Unit.

The Unit provides opportunities for candidates to develop aspects of the following Core Skills:

- *Numeracy* (SCQF level 6)
- *Problem Solving* (SCQF level 6)
- *Communication* (SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

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

Solve problems of static equilibrium for fundamental mechanical elements of engineering systems.

Performance Criteria

(a) Define mechanical stress and strain for direct and shear loading cases.
(b) Calculate tensile, compressive and shear stress and strain for simple mechanical components.
(c) Calculate reactions at supports for fundamental statically determinate beam structures.
(d) Correctly sketch shear force and bending moment diagrams for simply supported and cantilever beams.

OUTCOME 2

Apply Newton's laws of motion to solve fundamental linear and angular motion problems for engineering systems.

Performance Criteria

(a) Solve simple kinematics problems for linear and angular motion.
(b) Calculate the net force on a component undergoing uniform linear acceleration.
(c) Calculate the net torque on a component undergoing uniform angular acceleration.

OUTCOME 3

Analyse the relationships between input and output of fundamental mechanical engineering systems.

Performance Criteria

(a) Correctly defines inputs, outputs and losses for given engineering systems.
(b) Accurately measures and records the inputs and outputs of a given engineering system.
(c) Correctly analyses and evaluates the practical results and compares with theoretical estimates.
(d) Adhere to appropriate health and safety procedures and practices during practical work.

National Unit Specification: statement of standards (cont)

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EVIDENCE REQUIREMENTS FOR THIS UNIT

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

Written and/or recorded oral evidence, and where appropriate, recorded oral and performance evidence supplemented with an assessor observation checklist(s) should be produced to demonstrate that the candidate has achieved all the Outcomes and Performance Criteria.

Outcomes may be assessed on an individual basis. However Outcomes 1 and 2 may lend themselves to a single holistic assessment. Total assessment time for the Unit must not exceed four hours.

Assessments for Outcomes 1 and 2 must be conducted under supervised conditions in which candidates may use reference materials provided by the centre but are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment. Candidates can use a scientific calculator during assessment.

Candidate evidence for Outcome 3 must be in the form of a written and/or recorded oral report of a given practical assignment together with recorded oral and performance evidence supplemented with an assessor observation checklist(s). All practical activities undertaken as part of the assessment of Outcome 3 must be conducted under supervised conditions. An assessor observation checklist must be used to record evidence that candidates have complied with relevant safety regulations and safe working procedures and practices while undertaking practical work on a given engineering system.

For Outcome 1

- Definition of mechanical stress and strain for tensile, compressive and shear loading cases.
- From given examples of loading conditions (tensile, compressive and shear), correctly calculate maximum stress and strain values.
- From given beam loading conditions, correctly calculate the magnitude and direction of the reaction forces.
- Correctly sketch the shear force and bending moment diagrams for the given beam and calculated reaction forces.

For Outcome 2

- Displacement, velocity, acceleration, time (both linear and angular) are correctly analysed for a given engineering system.
- Calculate the net force on a component undergoing uniform linear acceleration.
- Calculate the net torque on a component undergoing uniform angular acceleration.

For Outcome 3

- Input and output quantities, correctly defined and measured for a given system, must include force, moment, torque, work and power.
- Mechanical Advantage, Velocity Ratio and Mechanical efficiency including losses are all correctly determined for a given system.
- Correct comparisons are made between measured and theoretical values.
- Adherence to appropriate health and safety procedures and practice.

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

UNIT Mechanical Engineering Principles (SCQF level 6)

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 SCQF level 6 Unit forms part of the National Certificate in Engineering Systems. This Unit may also be offered on a stand alone basis.

This Unit provides a suitable foundation of knowledge and understanding of mechanical engineering concepts and applications for candidates wishing to proceed to the HNC Engineering Systems.

The aim of this Unit is to allow candidates to develop a knowledge and understanding of fundamental mechanical engineering principles and to introduce them to effective problem solving techniques as a basis of applications to engineering systems of current industry relevance. This Unit should also allow the candidate to build upon knowledge gained in the SCQF level 5 Unit *Mechanical Engineering Principles*, and to develop a deeper understanding of the principles and practices adopted by the practising engineer in the modern engineering industry. The Unit has been designed to provide candidates with the skills to develop practical and workable solutions to mechanical engineering problems as applied within the context of engineering systems.

On successful completion of the Unit candidates will be able to undertake mechanical engineering calculations related to the fundamental static and dynamic behaviour structural elements in equilibrium. This aspect of the Unit will cover concepts of elementary static loading configurations and associated methods of simple stress analysis together with the kinematics and kinetic analysis of structural elements undergoing linear or rotational motion. Through a practical assignment on an engineering system, candidates will also develop the knowledge, understanding and skills to describe and measure typical mechanical quantities present in various types of engineering systems. Candidates will also be able to calculate different forms of mechanical quantities, energy losses due to friction, and overall efficiency associated with an engineering system. Such a practical activity will provide candidates with the capability to undertake fundamental investigations into the performance of mechanical engineering systems.

In the context of a National Certificate, centres may use this Unit in their programmes of study to provide candidates with an overview of mechanical aspects of engineering systems prior to developing concepts of integrated systems.

The following lists typical mechanical engineering systems as a guide to applications for consideration in the delivery of this Unit. This list is not intended to be exhaustive.

Typical mechanical systems that may be considered as part of this Unit may include: bicycle, lathe gearboxes, milling machines, pulley systems, worm and worm wheel, wheel and axle, wheel and differential axle, screw jack, winch systems, fan pumps, valves, motor vehicle sub-systems (eg clutch, brakes, gearbox), hydraulic and pneumatic systems, compressors, turbines or steam plant.

National Unit Specification: support notes (cont)

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GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is recommended that the Unit is delivered in the same sequence that the Outcomes are presented in the National Unit Specification: statement of standards section of the Unit.

This Unit may be delivered by a combination of lectures, tutorial work, investigations using paper based and electronic sources and practical exercises which may include candidates investigating engineering systems, or sub-systems, taking measurements and recording results. Notice should also be given to the constructional features and principle of operation of the engineering systems studied. Centres may also wish to allow candidates to perform experiments on engineering systems, or sub-systems, to investigate some of their performance characteristics.

It should be noted that the Internet contains a rich source of information on engineering systems.

Well-annotated wall charts of the layout and constructional features of engineering systems, or their sub-systems, can also act as an important source of learning.

For Outcome 1

Descriptions of direct, shear, bending, and torsion load applications should be covered. Stress and strain relationships for direct and shear loading cases should be explained and related to the Modulus of Elasticity and Modulus of Rigidity as appropriate. Applications of these relationships to simple loading cases could be complemented with some elementary laboratory testing. Shear force and bending moment distributions for simply supported and cantilever beam elements should be explained and sketched for simple loading cases.

For Outcome 2

Descriptions of constant speed and uniformly accelerating motion for simple linear and rotating elements should be explained and related to the respective forces and torques sustaining those motions through application of Newton's Laws of Motion. Application of these relationships should be made to calculate the force and torque on simple dynamic systems.

For Outcome 3

The quantities involved in establishing the mechanical energy, work and power balance of an engineering system should be explained and supplemented with a practical laboratory exercise to calculate the performance of a simple system. The experimental procedure, record of results and analysis of comparison between theory and practice should be documented in a short report. Attention must be paid to relevant health, safety and environmental aspects during the practical activity. Candidates' performance in all respect of the practical activity can be captured via an assessor observation checklist and by recording candidates' responses to assessor verbal questions.

National Unit Specification: support notes (cont)

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OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Reading component of the Core Skill *Communication* at SCQF level 6 may be developed in Outcome 3 while candidates are reading materials on aspects of engineering systems from paper based and electronic sources.

The Written component of the Core Skill *Communication* at SCQF level 6 may be developed in all three Outcomes while candidates are preparing written responses to formative and summative assessments.

The Critical Thinking component of the Core Skill *Problem Solving* at SCQF level 6 may be developed in all Outcomes while candidates carry out calculations and when investigating the performance of mechanical systems.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Formative and summative assessment exercises involving candidates carrying out analysis, investigative studies and recording of results of various types of mechanical engineering systems, describing mechanical quantities and energies, performing calculations on various engineering systems and whilst undertaking practical experimental work will play a particularly important role in building candidate knowledge, understanding and confidence of Unit content. The practical aspect of this Unit will also enable the candidate to formulate and build upon their theoretical knowledge of the system studied, thus reinforcing the theoretical content of this Unit.

Outcomes 1–2 Assessment may consist of an assessment paper comprising of mechanical calculations related to an engineering system. It is recommended that the assessment paper is taken at a single assessment event lasting 1 hour.

Outcome 3 Assessment may comprise of a practical exercise involving the measurement of mechanical quantities. Candidates should also check practical results by doing manual calculations in order to corroborate practical results Candidates may record results on forms provided by the centre. Candidate's performance in all respect of the practical activity can be captured via an assessor observation checklist and by a recorded record of candidate responses to assessor verbal questions. The practical exercise may last up to 3 hours.

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 Communication 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. 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).*

National Unit Specification: support notes (cont)

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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)**.