Higher National unit specification

General information

Unit title: Marine Engineering: Mechanics (SCQF level 8)

Unit code: HJ41 35

Superclass: XQ

Publication date: June 2017

Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This unit is designed to enable learner to further develop knowledge and understanding of engineering mechanics and the strength of materials in a mechanical and marine engineering environment. This unit is designed for use in the training of Merchant Navy Engineering Officers.

Outcomes

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

1 Explain and solve problems relating to centripetal and centrifugal forces involving clutches and governors.
2 Explain and solve problems relating to moments of area and mass.
3 Explain and solve problems relating to forces in engineering frameworks.
4 Explain and solve problems relating to the stability of axially loaded columns and stresses found within thin cylinders.

Credit points and level

1.5 Higher National unit credits at SCQF level 8: (12 SCQF credit points at SCQF level 8)

Recommended entry to the unit

Entry to this unit is at the discretion of the centre however it is recommended that the learner has completed the *Marine Engineering: Mechanical Principles SQCF Level 7* unit prior to enrolling on this unit.

Higher National unit Specification: General information (cont)

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Core Skills

Achievement of this unit gives automatic certification of the following Core Skills component:

Complete Core Skill None

Core Skill component Using Number at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the support notes of this unit specification.

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.

The Assessment Support Pack (ASP) for this unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website **(http://www.sqa.org.uk/sqa/46233.2769.html)**.

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: Marine Engineering: Mechanics (SQCF 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.

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. Learners 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

Explain and solve problems relating to centripetal and centrifugal forces involving clutches and governors

Knowledge and/or Skills

- Centripetal and centrifugal force
- Clutches
- Balancing of rotating masses
- Governors

Outcome 2

Explain and solve problems relating to moments of area and mass

Knowledge and/or Skills

- Moments of mass
- Moments of area
- Centroid of laminas made up of basic shapes

Outcome 3

Explain and solve problems relating to forces in engineering frameworks

Knowledge and/or Skills

- Stable, unstable and neutral equilibrium
- Struts and ties
- Pin Joints
- Reaction forces
- Bows Notation

Higher National unit specification: Statement of standards (cont)

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Outcome 4

Explain and solve problems relating to the stability of axially loaded columns and stresses found within thin cylinders.

Knowledge and/or Skills

- Hoop and longitudinal stress in thin cylinders
- Direct and shear stress on oblique seams of thin cylinder
- Axially loaded columns
- Buckling and slenderness ratio
- Euler formula

Evidence Requirements for this unit

Outcomes 1–4 should be combined using holistic assessment that should last no more than 3 hours. The assessment will be conducted under closed-book conditions however a formula sheet may be provided.

Learners are permitted to use a scientific calculator but not a programmable calculator.

Learners will need to provide evidence to demonstrate their Knowledge and/or skills across all Outcomes by showing that they can:

Outcome 1

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **three from four** Knowledge and/or Skills items should be provided in any assessment of this Outcome.

In order to ensure that the learner will not be able to foresee what items they will be questioned on, a different sample of three out of four Knowledge and/or Skills items is required each time the Outcome is assessed.

Where sampling takes place, a learner's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements by showing that the learner is able to:

- explain what is meant by centripetal and centrifugal force and solve a problem involving a body with angular velocity.
- explain by means of simple sketches a flat plate clutch, a conical clutch and a centrifugal friction clutch.
- solve a problem to determine the power transmitted to either, a flat plate clutch, a conical clutch, or a centrifugal friction clutch.
- solve a problem to determine the forces acting on bearings supporting out of balance shafts.
- explain the function and operation of a governor and solve a problem relating to either, a Watt governor, a Porter governor, or a Hartnell governor.

Higher National unit specification: Statement of standards (cont)

Unit title: Marine Engineering: Mechanics (SQCF level 8)

Outcome 2

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **two from three** Knowledge and/or Skills items should be provided in any assessment of this Outcome.

In order to ensure that the learner will not be able to foresee what items they will be questioned on, a different sample of two out of three Knowledge and/or Skills items is required each time the Outcome is assessed.

Where sampling takes place, a learner's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements by showing that the learner is able to:

- explain how a centre of gravity can be determined by taking moments of mass.
- explain how a centroid can be determined by taking moments of area.
- solve problems involving centroids for laminas made up of combinations of basic shapes.

Outcome 3

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **four from five** Knowledge and/or Skills items should be provided in any assessment of this Outcome.

In order to ensure that the learner will not be able to foresee what items they will be questioned on, a different sample of four out of five Knowledge and/or Skills items is required each time the Outcome is assessed.

Where sampling takes place, a learner's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements by showing that the learner is able to:

- explain the terms: stable, unstable and neutral equilibrium.
- explain the terms strut and tie and in what context they are used.
- explain the term pin joint as used in frame structures.
- determine the support reactions for simple frameworks subjected to a maximum of 3 vertically applied forces, by graphical and/or analytical methods.

Solve problems using Bow's Notation (via graphical or analytical means) related to pin joints and also the magnitude and nature of the force in the members of a simple framework

Outcome 4

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. Written and/or oral evidence based on a sample of **four from five** Knowledge and/or Skills items should be provided in any assessment of this Outcome.

Higher National unit specification: Statement of standards (cont)

Unit title: Marine Engineering: Mechanics (SQCF level 8)

In order to ensure that the learner will not be able to foresee what items they will be questioned on, a different sample of four out of five Knowledge and/or Skills items is required each time the Outcome is assessed.

Where sampling takes place, a learner's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements by showing that the learner is able to:

- solve a problem on hoop and longitudinal stress in a thin cylinder subjected to internal pressure.
- solve a problem involving direct and shear stresses on oblique seams of thin cylinders.
- explain the four basic end conditions for struts.
- explain the terms buckling and slenderness ratio.
- solve a problem involving the Euler formula for struts.

Higher National unit Support Notes

Unit title: Marine Engineering: Mechanics (SQCF 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 60 hours.

Guidance on the content and context for this unit

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

1 Explain and solve problems relating to centripetal and centrifugal forces involving clutches and governors.
2 Explain and solve problems relating to moments.
3 Solve problems relating to forces in engineering frameworks.
4 Solve problems relating to the stability of axially loaded columns; explain and solve problems relating to hoop and longitudinal stress in thin cylinders.

In each section it is advised that the question set should relate to terminology used on board ship.

1 Explain and solve problems relating to centripetal and centrifugal forces involving clutches and governors (18 hours)

- Flat clutches: normal reaction, contact pressure, contact area, friction torque. power. Cone clutches: normal reaction, contact pressure, contact area, relationship between thrust and normal reaction, friction torque power. Centrifugal friction clutches: centrifugal force, spring force, extension of spring, spring stiffness, friction at clutch rim, torque, power.
- Forces acting on bearings: friction torque, energy absorbed by friction, work done, power, energy, power absorbed by friction.
- Governors: sketch diagrams for Watt, Porter & Hartnell governors, spindle, light arm, sleeve, flyweights. Throttle control, instantaneous centre, moments about instantaneous centre, centrifugal force, central mass, spindle friction, spring, spring force.

2 Explain and solve problems relating to moments (18 hours)

- Moments of mass to find mass moment of inertia of shapes including solid and hollow discs, flywheels.
- Moments of area of simple engineering components and beam cross sections; I-beams, circular, rectangular.
- Solve problems involving centroids for laminas made up of combinations of: Rectangles, Circles, Triangles, Semi circles.

Higher National unit Support Notes (cont)

Unit title: Marine Engineering: Mechanics (SQCF level 8)

3 Solve problems relating to forces in engineering frameworks (12 hours)

- Problems in relation to crane frameworks and cranes lifting engine room machinery.

4 Solve problems relating to the stability of axially loaded columns; explain and solve problems relating to hoop and longitudinal stress in thin cylinders (12 hours)

- Topics covered but not limited to stresses on oblique planes, complimentary shear stress, hoop and longitudinal stress in a thin cylinder subjected to internal pressure.
- Topics covered but not limited to will include, combined bending and direct stresses on columns, buckling and slenderness ratio, four basic end conditions for struts, Euler formula for struts.

This unit along with Marine Engineering: Applied Mechanics and Marine Engineering: Strength of Materials is designed to include everything in the revised MCA Chief Engineer Reg III/2 Applied Mechanics Syllabus and as such should be used in conjunction with these guidance notes to bench mark the required standards.

Guidance on approaches to delivery of this unit

Practical demonstration and realistic problem solving should support the application of advanced mechanics principles and concepts. Computer software could be made available where appropriate and learner may be encouraged to take a logical problem solving approach throughout.

The unit has been written such that there is sufficient time built in for learner to practise what they have learnt through appropriate formative assessment exercises. Additionally, the unit has been designed to incorporate time for some experimental work and computer simulations (these will not be formally assessed in the unit) so that learners have an opportunity to confirm theories in practice. Whilst, it is recognised that computer simulation can be a valuable tool in confirming mechanical theories, it is nevertheless felt important that learners do some practical laboratory work so that they can gain experience in using test equipment and analysing the results of experiments.

Where this unit is incorporated into other Group Awards it is recommended that it be delivered in the context of the specific occupational area(s) that the award is designed to cover.

Guidance on approaches to assessment of this unit

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.

Higher National unit Support Notes (cont)

Unit title: Marine Engineering: Mechanics (SQCF level 8)

The assessment for all four Outcomes of this unit should be combined together into one assessment paper. This paper could be taken by learner at one single assessment event that should last no more than three hours. Assessment should be conducted under closed-book, controlled and supervised conditions. Learners are permitted to use a scientific calculator but not a programmable calculator. Where sampling is used an alternative sample should be used when reassessing learner. Assessment should take place under invigilated conditions and follow the assessment centres examination policy.

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**.

Opportunities for developing Core and other essential skills

In all Outcomes of this unit learners are required to use a wide range of numerical methods to solve complex problems. This falls under the SCQF Level 6 Core Skill Numeracy. The tasks that the learner will perform will often be unfamiliar and require them to develop their knowledge to solve more realistic and challenging problems.

The assessment of this unit may contribute towards the component 'Written Communication (writing)' of the Core Skill Communication at SCQF level 6. Learners may have to structure their responses, which could include varying structure and presenting essential information in a logical manner. The specific Core Skill elements that learner may have to complete are 'Present all essential ideas/information and supporting detail in a logical and effective order' and 'Vary sentence structure, paragraphing, and vocabulary to suit the purpose and target audience'.

This unit has the Using Number component of Numeracy embedded in it. This means that when learners achieve the unit, their Core Skills profile will also be updated to show they have achieved Using Number at SCQF level 6.

History of changes to unit

Version	Description of change	Date
02	Core Skills component Using Number at SCQF level 6 embedded.	01/06/17

General information for learners

Unit title: Marine Engineering: Mechanics (SQCF 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 has been developed to further broaden knowledge gained at HNC level. The skills you learn here will allow you to develop a deep level of understanding of complex engineering problems and the methodologies in which to solve them. Your numeracy skills will be put to the test as you perform complex calculations throughout the module.

All the principles learnt here can easily be related to the marine engineering industry. Taking the fundamental concepts learnt within the classroom to a practical environment on board will further enhance your level of understanding.

By the end of this unit you will sit a single assessment covering all four learning Outcomes. In order to be successful in this assessment you need to demonstrate a high level of knowledge and understanding of the four learning Outcomes. You will also need to accurately complete complex calculations and understand the Outcome. As you solve these complex problems you should be able to assess the Outcome and develop ideas on how to improve the engineering process. Such skills in understanding and developing ideas into a practical environment will enhance your career as a marine engineering officer.

By completing the units *Marine Engineering: Applied Mechanics* and *Marine Engineering: Strength of Materials* as part of the HND Marine Engineering programme you will have covered the MCA revised Chief Engineer Reg III/2 Applied Mechanics syllabus.

This unit has the Using Number component of Numeracy embedded in it. This means that when you achieve the unit, your Core Skills profile will also be updated to show you have achieved Using Number at SCQF level 6.