Higher National Unit specification

General information for centres

Unit title: Marine Engineering**:** Dynamics and Machines

Unit code: F90V 34

Unit purpose: This Unit is designed to enable candidates to develop knowledge and understanding of dynamic and machine mechanical systems and how these principles are relevant in a Marine Engineering Environment. This Unit is designed for use in the training of Merchant Navy Engineering Officers.

On completion of the Unit the candidate should be able to:

1 Explain and solve problems involving linear, angular and relative motion.
2 Explain and solve problems involving dynamics for linear and angular systems.
3 Explain and solve problems relating to fluids in motion.
4 Explain the principles of simple machines and solve associated problems.

Credit points and level: 1 HN credit(s) at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**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.*

Recommended prior knowledge and skills: Candidates should have knowledge of mathematics and/or physics at SCQF level 6 or a National Certificate in Engineering at SCQF level 6.

Core Skills: There are opportunities to develop the Core Skill(s) of *Numeracy*, *Information and Communication Technology* and *Communication* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

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.

Assessment: The assessment for all four Outcomes of this Unit could be combined together into one assessment paper. This paper could be taken by candidates at one single assessment event that should last two and a half hours. Assessment should be conducted under closed-book, controlled and supervised conditions. Candidates are permitted to use a scientific calculator but not a programmable calculator.

Higher National Unit specification: statement of standards

Unit title: Marine Engineering: Dynamics and Machines

Unit code: F90V 34

The sections of the Unit stating the Outcomes, Knowledge and/or Skills, and Evidence Requirements are mandatory.

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. Candidates 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 involving linear, angular and relative motion.

Knowledge and/or Skills

- Displacement, velocity, speed and acceleration for linear motion.
- Distance time graphs for constant velocity, linear motion.
- Velocity time graphs for uniform acceleration, linear motion.
- Linear velocity equations.
- Displacement, velocity, speed and acceleration for angular motion.
- Distance time graphs for constant velocity, angular motion.
- Velocity time graphs for uniform acceleration, angular motion.
- Angular velocity equations.
- Relationship between linear and angular motion.
- Motion of projectiles.
- Relative velocity.

Evidence Requirements

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **seven** f**rom eleven** knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of **seven out of eleven** knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all **seven** items.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Dynamics and Machines

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

- Explain the terms displacement, velocity, speed and acceleration for linear motion.
- Sketch a linear motion distance/time graph for constant velocity with the slope as velocity and solve a problem using the graph.
- Sketch a linear motion velocity/time graph for uniform acceleration with the slope as acceleration and solve a problem using the graph.
- Derive the equations for linear velocity and use these equations to solve a problem.
- Explain the terms displacement, velocity, speed and acceleration for angular motion.
- Sketch an angular motion distance/time graph for constant velocity with the slope as velocity and solve a problem using the graph.
- Sketch an angular motion velocity/time graph for uniform acceleration with the slope as acceleration and solve a problem using the graph.
- Derive the equations for angular velocity and use the equations to solve a problem.
- Derive the relationship between linear and angular motion and solve a problem using the relationship.
- Solve a problem that involves an inclined projectile.
- Solve a problem that involves relative velocity.

Evidence should be generated under controlled conditions.

Assessment Guidelines

Questions used to elicit candidate evidence could take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment of this Outcome could be combined with that for Outcome 2, 3 and 4 to form a single assessment paper, details of which are given under Outcomes 2, 3 and 4.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Dynamics and Machines

Outcome 2

Explain and solve problems involving dynamics for linear and angular systems.

Knowledge and/or Skills

- Newton's 1st law of motion.
- Force, mass and acceleration.
- Linear momentum.
- Newton's 2nd law of motion.
- Newton's 3rd law of motion.
- Tractive effort and tractive resistance.
- Conservation of linear momentum.
- Work done and energy.
- Potential energy and kinetic energy.
- Conservation of energy.
- Power, force and velocity.
- Work diagrams.
- Torque.
- Centripetal acceleration and centripetal force.
- Centrifugal force.
- Balanced and unbalanced forces (coplanar rotating mass system).

Evidence Requirements

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **ten from sixteen** knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of **ten out of sixteen** knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all **ten** items.

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

- Explain Newton's 1st law of motion.
- Derive force = mass x acceleration and solve a problem using the equation.
- Explain and solve a problem on linear momentum
- Explain Newton's 2nd law of motion.
- Explain Newton's 3rd law of motion.
- Solve a problem involving tractive effort and resistance, including mass, acceleration and friction on either a vertical or inclined plane.
- Solve a problem involving the conservation of momentum.
- Solve a problem involving energy, work and power.
- Explain and solve a problem involving potential and kinetic energy.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Dynamics and Machines

- Explain and solve a problem on the conservation of energy.
- Derive power = force x velocity and solve a problem using the equation.
- Sketch work diagrams for both constant forces and uniformly varying forces and solve a problem involving work diagrams.
- Solve a problem using Work Done = T x Θ: Power = T x ω = 2πNT.
- Explain and solve a problem involving centripetal acceleration and centripetal force.
- Explain and solve a problem involving centrifugal force.
- Solve a problem to determine the unbalanced force and balancing mass required for a coplanar rotating mass not in equilibrium.

Evidence should be generated under controlled conditions.

Assessment Guidelines

Questions used to elicit candidate evidence could take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment of this Outcome could be combined with that for Outcome 1, 3 and 4 to form a single assessment paper, details of which are given under Outcomes 1, 3 and 4.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Dynamics and Machines

Outcome 3

Explain and solve problems relating to fluids in motion.

Knowledge and/or Skills

- Continuity equation.
- Bernoulli's equation.
- Discharge of a fluid through a sharp edged orifice.

Evidence Requirements

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **two from three** knowledge and/or skills items should be sampled.

In order to ensure that the candidates 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. Candidates must provide a satisfactory response to all **two** items.

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

- Explain the continuity equation in terms of both volume and mass and solve problems involving the continuity equation.
- Solve a flow problem using Bernoulli's equation involving tapering pipes positioned either horizontally, vertically or inclined. Pipe friction to be ignored.
- Explain the concepts of coefficients of velocity, area and discharge and define the motion of a jet in relation to the projectile theory. Also, solve a problem involving the flow of liquids through a sharp edge orifice under a constant liquid head.

Evidence should be generated under controlled conditions.

Assessment Guidelines

Questions used to elicit candidate evidence could take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment of this Outcome could be combined with that for Outcome 1, 2 and 4 to form a single assessment paper, details of which are given under Outcomes 1, 2 and 4.

Higher National Unit specification: statement of standards (cont)

Unit title: Marine Engineering: Dynamics and Machines

Outcome 4

Knowledge and/or Skills

Explain the principles of simple machines and solve associated problems.

- Lifting machine.
- Effort, load, mechanical advantage, velocity ratio and efficiency.
- Transmission of power and torque through a compound gear system.
- Graphs of: Effort/Load, MA/Load, Efficiency/Load for lifting machines.
- Law of a machine.
- Vee belt power transmission.

Evidence Requirements

Evidence for the knowledge and or skills in this Outcome will be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **four from six** knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of **four out of six** knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all **four** items.

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

- Explain the concept of a lifting machine.
- Explain the terms: Effort, Load, Mechanical Advantage (MA), Velocity Ratio (VR) and efficiency in respect of, a wheel and axle, differential wheel and axle, rope pulley block, differential rope pulley block, chain block, screw jack, Warwick screw, worm and wheel mechanisms and a hydraulic jack. Solve a problem related to a minimum of 3 aforementioned devices.
- Explain how power and torque is transmitted through simple and compound gearing systems. Solve a problem involving speed ratio, power and torque transmitted for a simple or compound gearing system.
- Sketch graphs of: Effort /Load, Efficiency/Load for lifting machines.
- Explain and derive the law of a machine.
- Derive the torque transmitted in terms of belt tensions and solve a problem involving: speed ratios, power and torque transmitted for a belt drive system.

Evidence should be generated under controlled conditions.

Assessment Guidelines

Questions used to elicit candidate evidence could take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment of this Outcome could be combined with that for Outcome 1, 2 and 3 to form a single assessment paper, details of which are given under Outcomes 1, 2 and 3.

Administrative Information

Unit code: F90V 34

Unit title: Marine Engineering**:** Dynamics and Machines

Superclass category: XQ

Original date of publication: August 2010

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History of changes:

Version	Description of change	Date

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre for further details, telephone 0845 279 1000.

Higher National Unit specification: support notes

Unit title: Marine Engineering: Dynamics and Machines

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

1 Explain and solve problems involving linear, angular and relative motion.
2 Explain and solve problems involving dynamics for linear and angular systems.
3 Explain and solve problems relating to fluids in motion.
4 Explain the principles of simple machines and solve associated problems.

Lecturers are advised to study the following list of topics, below, in conjunction with the Statement of Standards section of this specification.

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

1 Explain and solve problems involving linear, angular and relative motion. (10 hours)

- Linear velocity problems of ships travelling at sea
- Linear velocity problems of sliding mechanisms and engine crossheads
- Angular velocity problems of rotating ships machinery such as, crankshafts, fly wheels, pulleys and pump shafts.
- Relative velocity problems involving ships' positions and nearest approach.
- Projectile problems involving emergency flares/ rockets, and heaving lines.

2 Solve problems involving dynamics for linear and angular systems. (10 hours)

- Momentum force and mass problems of marine machinery or stores being hauled across horizontal, inclined decks and problems involving engine room lifts and hoists.
- Conservation of momentum problems of loose colliding machinery components.
- Angular motion problems of rotating ships' machinery such as, crankshafts, fly wheels, pulleys and pump shafts.
- Potential and kinetic energy of loads swinging at the end of a crane.
- Torque, work done and power problems of specific marine machinery
- Centripetal acceleration of fuel oil separators and engine flywheels.
- Centrifugal force problems of fuel oil separators turbine rotors/blades and simple engine governors.
- Balancing of rotating masses of turbine rotors.

3 Solve problems relating to fluids in motion. (10 hours)

- Problems related to pressure and flow in sea water systems, fresh water systems,
- fuel oil systems and lubricating oil systems.
- Problems related to release of fluids through a holed tank.

4 Explain the principles of simple machines and solve associated problems (10 hours)

- Lifting and jacking equipment as used in the maintenance and repair of specific machinery such as engines, pumps, compressors, steering gear etc.
- Belt drive systems as used for drives between electric motor and fridge compressor or air compressor or air conditioning Unit or hydrophore pump.
- Simple gear train systems as used for gangway hoist, crab winch, air winch gear box.

Higher National Unit specification: support notes (cont)

Unit title: Marine Engineering**:** Dynamics and Machines

Guidance on the delivery and assessment of this Unit

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

The Unit has been written such that there is sufficient time built in for candidates to practise what they have learnt through appropriate formative assessment exercises. Additionally, the Unit has been designed to incorporate time for experimental work and computer simulations so that candidates 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 candidates do some practical laboratory work so that they can gain experience in using test equipment and analysing the results of experiments.

As this Unit provides core dynamics and principles which underpin much of the studies done in other areas of the HNC and HND Marine Engineering awards it is recommended that the Unit be delivered towards the start of these awards.

Opportunities for developing Core Skills

In completing each Outcome candidates may have the opportunity to develop the component 'Critical Thinking' of the Core Skill *Problem Solving* at level 6. Candidates will have the opportunity to problem solve using simulation and develop a strategy to solve them. The specific Core Skill elements that the candidate may have to complete are 'Identify the factors involved in the situation or issue' and 'Assess the relevance of these factors to the situation or issue'.

When candidates are completing the Outcomes there are opportunities to reinforce theories through laboratory work. Candidates may have the opportunity to develop the component 'Planning and Organising' of the Core Skill *Problem Solving* at SCQF level 6. Candidates may complete a complex task in the laboratory and may have the opportunity to complete the specific Core Skill elements 'Develop a plan', 'Identify and obtain resources to carry out the plan' and 'Carry out the task'. In addition this laboratory work may allow candidates to develop the Core Skill of *Working with Others* at SCQF level 6. This laboratory work may allow candidates to develop the specific Core Skill elements 'Negotiate working methods' and 'Promote co-operative working with others, progress towards shared goals'.

There are opportunities for candidates to use computer simulators in each of the Outcomes of this Unit. This may allow candidates to develop the component 'Providing/creating information' of the Core Skill of *Information and Communication Technology* at SCQF level 6. Through the use of computer simulation candidates may develop the specific Core Skill elements 'Resolve simple hardware or software problems', 'Use software in unfamiliar contexts', 'Evaluate information' and 'Present findings in an appropriate format'.

Higher National Unit specification: support notes (cont)

Unit title: Marine Engineering: Dynamics and Machines

In all Outcomes each of the assessments requires the candidate to be able to solve problems involving statics. This will give the candidate the opportunity to develop the component 'Using number' of the Core Skill *Numeracy* at SCQF level 6. The specific Core Skill elements that the candidate will have to complete are 'Work confidently to solve a numerical problem' and 'Decide on the steps and operations to be carried out to solve a complex problem'.

In Outcome 1 candidates have an opportunity to apply graphical skills when interpreting and presenting information. This will give the candidate the opportunity to develop the component 'Using graphical information' of the Core Skill *Numeracy* at SCQF level 6. In the drawing of linear motion graphs candidates will develop the specific Core Skill elements 'Extract, analyse, and interpret graphical information' and 'Select an appropriate form of complex table, chart, diagram, or qualitative form and communicate complex information in that form'.

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that the assessment is conducted under controlled, supervised conditions.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**

General information for candidates

Unit title: Marine Engineering**:** Dynamics and Machines

This Unit has been designed to allow you to develop knowledge, understanding and skills in dynamics and machines concepts and theorems that underpin so much of more advanced studies in Mechanical/Marine Engineering. If you have studied these subjects before the early parts of this Unit it will provide you with an opportunity to revise the concepts and theorems you have learnt in previous courses.

It is good to gain sound theoretical knowledge and understanding but it is also important that you are able to set your theoretical knowledge within a practical Mechanical/Marine context. Thus, it is likely that during the Unit that you will be provided with the opportunity to relate theory to practice by doing practical experiments and computer simulations on mechanical problems.

By the end of the Unit you will be expected to solve dynamics and machines problems using the concepts and theorems you have learned.

The formal assessment for this Unit could consist of a single assessment paper lasting two and a half hours. The assessment will be conducted under closed-book conditions in which you will not be allowed to take notes, textbooks etc, into the assessment. However, you will be allowed to use a scientific calculator. You may sit this assessment paper at the end of the Unit.

This Unit will contribute to the Graded Unit for candidates studying towards an HNC or HND in Marine Engineering.