SQA Advanced Unit Specification

General information for centres

Unit title: Civil Engineering: Fluid Mechanics

Unit code: HR5C 48

Unit purpose: This Unit is designed to enable candidates to gain a basic knowledge and understanding of fluid mechanics, in order to solve problems relating to submerged surfaces, pipelines, pumps and channel flow.

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

1 Analyse problems relating to hydrostatic pressures on vertical submerged plain surfaces.
2 Apply the equations of continuity and energy to pipelines and pumps.
3 Apply the momentum equation to evaluate forces generated by fluid flow.
4 Apply standard solutions to open channel flow problems.

Credit points and level: 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*)

**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 National 1 to Doctorates.*

Recommended prior knowledge and skills: Access to this Unit is at the discretion of the centre, but it would be advantageous for candidates to have a basic knowledge and understanding of loadings and basic structural mechanics. This may be evidenced by completion of a structural mechanics unit or equivalent prior knowledge.

Core Skills: There are opportunities to develop the Core Skills of Communication, Numeracy, IT, and Problem Solving 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: It is possible to assess candidates either on an individual Outcome basis, a combination of Outcomes or by a single holistic assessment combining all Outcomes. The assessment paper/s should be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be conducted under supervised, controlled conditions. A single assessment covering all outcomes should not exceed three hours in duration. It should be noted that candidates must achieve all the minimum evidence requirements specified for each Outcome in order to pass this Unit.

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 Knowledge/Skill items should be sampled on each assessment occasion.

An exemplar instrument of assessment and marking guidelines has been produced to provide examples of the type of evidence required to demonstrate achievement of the aims of this Unit and to indicate the national standard of achievement at SCQF level 8.

SQA Advanced Unit specification: statement of standards

Unit title: Civil Engineering: Fluid Mechanics

Unit code: HR5C 48

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

Analyse problems relating to hydrostatic pressures on vertical submerged plane surfaces

Knowledge and/or skills

- Densities and unit weights of different fluids.
- Pressure at various depths due to static fluid.
- Pressures at various depths due to two fluids of different density.
- Resultant forces and centres of pressure on vertical submerged plane surfaces.
- Equations of statics to evaluate moments on submerged vertical plane surfaces.

Evidence Requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- calculate the resultant force and centre of pressure on a vertical submerged plane surface
- use equations of statics to analyse forces on vertical submerged surfaces

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all the Evidence Requirements, this must be provided by manual calculations.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open book conditions.

Assessment guidelines

The assessment for this Outcome might be combined with those for some or all of the other outcomes in the Unit.

Outcome 2

Apply the equations of continuity and energy to pipelines and pumps

Knowledge and/or skills

- The equations of continuity and energy applied to pipes
- Head losses in single pipes and fittings
- Head losses in pipes using computer software
- System head graphs
- Pump curves and selection of pump

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- solve problems in pipe flow by calculating energy losses
- select a suitable pump for a particular situation

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all the Evidence Requirements; this must be provided by manual/computer calculations. Where computer software is used to determine energy losses candidates must demonstrate their understanding of the process by means of a sample of manual calculations.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open book conditions.

Assessment guidelines

The assessment of this Outcome might be combined with those for some or all of the other outcomes in this Unit.

Outcome 3

Apply the momentum equation to evaluate forces generated by fluid flow

Knowledge and/or skills

- The momentum equation
- Forces generated by the flow of liquid
- Component forces generated at pipe bends

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- calculate the force generated by a jet of liquid on a fixed plate
- calculate the magnitude and direction of the resultant force generated by a fluid flowing in a pipe at a bend

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **two out of three** knowledge and/or skills items should be sampled. . Candidates must provide a satisfactory response to all the Evidence Requirements; this must be provided by manual calculations.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open book conditions.

Assessment guidelines

The assessment for this Outcome might be combined with those for some or all of the other outcomes in this Unit.

Outcome 4

Apply standard solutions to open channel flow problems

Knowledge and/or skills

- Uniform flow in open channels
- Flow in part-full circular pipes
- Channel and pipe flow
- Non-uniform flow in open channels

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- description of uniform and non-uniform flow in open channels and their uses in practice
- solve problems in open channel uniform flow using standard formulae

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of four** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all the Evidence Requirements. Where computer software is used to solve problems, candidates must demonstrate their understanding of the process by means of a sample of manual calculation.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under open book conditions.

Assessment guidelines

The assessment for this Outcome might be combined with those for some or all of the other outcomes in this Unit.

Administrative Information

Unit code: HR5C 48

Unit title: Civil Engineering: Fluid Mechanics

Superclass category: TL

Date of publication: August 2017

Version: 01

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit specification: support notes

Unit title: Civil Engineering: Fluid Mechanics

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 Analyse problems relating to hydrostatic pressures on vertical submerged surfaces.
2 Apply the equations of continuity and energy to pipelines and pumps.
3 Apply the momentum equation to evaluate forces generated by fluid flow.
4 Apply standard solutions to open channel flow problems.

This Unit is at SCQF level 8 and has been developed as part of the new SQA Advanced Certificate and SQA Advanced Diploma in Civil Engineering awards.

Throughout the Unit emphasis will be placed where appropriate on the application of Health and Safety and Sustainability. Safe working practices should be looked at in accordance with current safety codes of practice and regulations. Sustainability should include reference to criteria affecting sustainability, impact of not implementing sustainability on the environment and the legislation promoting sustainability.

In designing this Unit, the unit writer has identified the range of topics which would be expected to be covered by lecturers. While it is not mandatory for a centre to use this list of topics it is strongly recommended that it does so.

The list of topics is given below. Lecturers are advised to study this list of topics in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit

1 Analyse problems relating to hydrostatic pressures on vertical submerged surfaces (10 hours)

Densities: Terminology and abbreviations and definitions used in fluid mechanics. Densities of common liquids. Conversion of density to unit weight. ($\gamma = \rho \times 9.81$)

Pressures: Pressure at depth h formula. ($P = \gamma h$). Pressure variation with depth diagrams. Location of centre of pressure. Location of centroid of a triangle.

Forces: Calculation of total force. Force = area of pressure triangle.

Statics: Use of the equations of statics $\Sigma F_v = 0$ $\Sigma F_h = 0$ $\Sigma M_o = 0$ to solve hydrostatic fluid problems, such as submerged piles, forces on fluid containing tanks, submerged flap valves etc.

2 Apply the equations of continuity and energy to pipelines and pumps (11 hours)

Energy equation: Description and explanation of the energy equation terms. Energy head at point 1 = Energy head at point 2 ± energy head losses between 1 and 2. Total head= Pressure head + Velocity head + Static head. Pressure Head = $P/\rho g$ metres of fluid. Velocity Head = $v^2/2g$ metres of fluid. Static Head = z metres of fluid.

Head Losses: Darcy Weisbach equation, Head losses in pipes = $4flv^2/2gD$ metres of fluid. Head losses in standard pipe fittings = $kv^2/2g$ metres of fluid. Solve problems on pipe flow using above formulae and computer software.

Pumps: System head curves. Flow against total head loss. Pump curves compared with system head curves to obtain appropriate pump, impeller and operating point.

3 Apply the momentum equation to evaluate forces generated by fluid flow (9 hours)

Momentum equation: Describe and explain the momentum equation.

Forces: Force of a jet on a stationary plate = rate of change of momentum = mass/sec x change of velocity. ie $P = (\rho av) \times \Delta v$ Newtons. Force on a moving plate $P = \rho a(v-u) \times (v-u) = \rho a(v-u)^2$. Forces on bends. Use of Pythagoras to calculate forces. $P_x = PA\cos\theta$ $P_y = PA\sin\theta$ $P_r = \sqrt{(P_x^2 + P_y^2)}$
$\tan\theta = P_y/P_x$

4 Apply standard solutions to open channel flow problems. (10 hours)

Uniform flow in channels/pipes: Explanation of the terms: open channel, uniform flow, wetted perimeter and hydraulic mean depth. Hydraulic mean depth, Chézy formula, Manning formula. Use of the above formulae to solve problems in rectangular, V-shaped, trapezoidal and circular channels (partly filled pipes). Use of computer software to solve problems in channel flow.

Non-uniform Flow: Non-Uniform flow described and examples given. Specific Energy (E), graphs of depth verses Q and depth verses E. Critical depth and critical velocity defined. Examples given of supercritical flow i.e. hydraulic jumps, flow over submerged weirs, flow from gentle to steep slopes etc.

Guidance on the delivery and assessment of this Unit

Where available, evidence from the workplace can also be incorporated to enhance the learning outcomes, provided that this evidence is appropriate and authenticated as the student's own work.

It is recommended that wherever possible practical laboratory work is included in the delivery and assessment of this Unit.

It is recommended that evidence for learning outcomes is achieved through well-planned course work, assignments and projects. Assessment may be formative and summative and both may feature as part of the process. Although assessments must be focused on the individual achievement of each student, group work and role-play activities may contribute to the assessment. Integrative assignments and project work will help to link this Unit with other related units.

The volume of evidence required for each assessment should take into account the overall number of assessments being contemplated within this Unit and the design of the overall teaching programme.

Opportunities for developing Core Skills

The following grid provides a general guide to opportunities for the development of Core Skills in this Unit. Opportunities for the development of Core Skills at the output level are more fully identified in the Core Skills Signposting Guide.

Core Skill	Outcome 1	Outcome 2	Outcome 3	Outcome 4
1 Communication				
Reading				
Writing				3
Oral				
2 Numeracy				
Using Number	3	3	3	3
Using Graphical Information	3	3		
3 IT				
Using Information Technology		3		3
4 Problem Solving				
Critical Thinking	3	3		
Planning and Organising				
Reviewing and Evaluating				
5 Working with Others				

Open learning

Given that appropriate learning materials exist 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. Arrangement would be required to be put in place to ensure that the assessment, which is required to be as two events, was conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to SQA guide Assessment and Quality Assurance of Open and Distance Learning (SQA 2000)

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.

General information for candidates

Unit title: Civil Engineering: Fluid Mechanics

This Unit has been designed to allow you to develop knowledge, understanding and skills in:

1 Analysing problems relating to hydrostatic pressures on vertical submerged plain surfaces.
2 Appling the equations of continuity and energy to pipelines and pumps.
3 Appling the momentum equation to evaluate forces generated by fluid flow.
4 Appling standard solutions to open channel flow problems.

The formal assessments for this Unit may consist of the assessment of individual outcomes or a combination of outcomes or the assessment of the unit as a whole. The assessments will be conducted under open book conditions.