## Qualification at a glance

<table>
<thead>
<tr>
<th>Subject area</th>
<th>Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>City &amp; Guilds number</td>
<td>9209-03</td>
</tr>
<tr>
<td>Age group approved</td>
<td>18+</td>
</tr>
<tr>
<td>Entry requirements</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Assessment
- Externally set, internally marked assignments
- Dated written papers

### Fast track
- N/A

### Support materials
- Qualification handbook
- Assessment pack
- Sample assignments
- Online tutor and learner support material

### Registration and certification
- Consult the Walled Garden/Online Catalogue for last dates

### Title and level

<table>
<thead>
<tr>
<th>Title and level</th>
<th>City &amp; Guilds number</th>
<th>Accreditation number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4 Diploma in Civil Engineering</td>
<td>9209-03</td>
<td>601/5535/8</td>
</tr>
</tbody>
</table>

### Version and date

<table>
<thead>
<tr>
<th>Version and date</th>
<th>Change detail</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.1 Oct 2014</td>
<td>Test specifications added. Grading information added.</td>
<td>4 Assessment 5 Grade profile</td>
</tr>
<tr>
<td>V1.2 Dec 2014</td>
<td>Range amended (units 442, 444 &amp; 447), and assessment criteria reworded (unit 447)</td>
<td>6 Units</td>
</tr>
<tr>
<td>V1.3 Jan 2015</td>
<td>UAN numbers and QAN added.</td>
<td>1 Introduction (Structure) and 6 Units</td>
</tr>
<tr>
<td>V1.4 March 2015</td>
<td>Minor amendment to assessment strategy regarding sample questions</td>
<td>4 Assessment</td>
</tr>
</tbody>
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<td></td>
<td>Approval</td>
<td>6</td>
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<tr>
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<td>Unit 439 Applied Mathematics for Civil Engineering</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Unit 440 Site Surveying</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Unit 441 Structural Mechanics</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Unit 442 Geotechnics and Soil Mechanics</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Unit 443 Materials for Civil Engineering</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Unit 444 Hydraulics in Civil Engineering</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Unit 445 Highway Engineering</td>
<td>40</td>
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<td></td>
<td>Unit 446 Communications, Manual Drafting and CAD for Engineers</td>
<td>42</td>
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<tr>
<td></td>
<td>Unit 447 Civil Engineering Construction Techniques</td>
<td>46</td>
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<tr>
<td></td>
<td>Appendix 1 Sources of general information</td>
<td>49</td>
</tr>
</tbody>
</table>
1 Introduction

This document tells you what you need to do to deliver the qualification:

<table>
<thead>
<tr>
<th>Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who is the qualification for?</td>
<td>It for learners who work or want to work as Civil Engineers in the Engineering sector</td>
</tr>
<tr>
<td>What opportunities for progression are there?</td>
<td>It allows learners to progress into employment or to the following City &amp; Guilds qualifications:</td>
</tr>
<tr>
<td></td>
<td>• Level 5 Advanced Technician Diploma in Civil Engineering</td>
</tr>
</tbody>
</table>
## Structure

To achieve the **Level 4 Diploma in Civil Engineering** learners must achieve the **five** mandatory units plus a minimum of **three** optional units. Learners may choose the elective unit but this will not count towards the optional units.

<table>
<thead>
<tr>
<th>City &amp; Guilds unit number/UAN</th>
<th>Unit title</th>
<th>Unit Level</th>
<th>GLH</th>
<th>NLH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mandatory units</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 439 R/506/9181</td>
<td>Applied Mathematics for Civil Engineering</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Unit 440 Y/506/9182</td>
<td>Site Surveying</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Unit 441 D/506/9183</td>
<td>Structural Mechanics</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Unit 442 H/506/9248</td>
<td>Geotechnics and Soil Mechanics</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Unit 443 K/506/9249</td>
<td>Materials for Civil Engineering</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td><strong>Optional units</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 444 D/506/9250</td>
<td>Hydraulics in Civil Engineering</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Unit 445 H/506/9251</td>
<td>Highway Engineering</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Unit 446 K/506/9252</td>
<td>Communications, Manual Drafting and CAD for Engineers</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td>Unit 447 M/506/9253</td>
<td>Civil Engineering Construction Techniques</td>
<td>4</td>
<td>60</td>
<td>150</td>
</tr>
<tr>
<td><strong>Elective unit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 422 A/506/9305</td>
<td>Personal and Professional Development</td>
<td>4</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
2 Centre requirements

Approval
If there is no fast track approval for this qualification, existing centres who wish to offer this qualification must use the standard Qualification Approval Process.

Resource requirements

Physical resources and site agreements
The equipment, systems and machinery must meet industrial standards and be capable of being used under normal working conditions.

Centre staffing
Staff delivering this qualification must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the areas for which they are delivering training and experience of providing training. This knowledge must be to the same level as the training being delivered
- Trainers must hold or be working towards a recognised training qualification.
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Centre staff may undertake more than one role, eg tutor and assessor or internal quality assurer, but cannot internally verify their own assessments.

Assessors and Internal Quality Assurer

Assessors
Although not specifically required for this qualification, City & Guilds recommends that Assessors hold, or are working towards, the relevant Level 3 TAQA qualification, covering the assessment types required for this qualification. Further information about the City & Guilds TAQA qualification can be found at www.cityandguilds.com. Assessors must be able to demonstrate clear experience in assessing learning and understand City & Guilds’ quality assurance requirements. They must also have the required industry certification and experience as outlined above.

Internal Verifiers / Internal Quality Assurers
Although not specifically required for this qualification, City & Guilds recommends that Internal Verifiers / Internal Quality Assurers hold, or are working towards, the Level 4 TAQA qualification. Further information about the City & Guilds TAQA qualification can be found at
Internal Verifiers / Internal Quality Assurers must be able to demonstrate clear experience in quality assurance processes and understand City & Guilds’ specific quality assurance requirements. They must also have the required industry certification and experience as outlined above.

**Continuing professional development (CPD)**

Centres must support their staff to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

**Learner entry requirements**

City & Guilds recommends that learners have completed a suitable engineering related qualification at level 3 or above prior to enrolling on the course.

Without evidence of formal qualifications, learners must demonstrate adequate prior knowledge and experience to ensure they have the potential to gain the qualification.

**Age restrictions**

City & Guilds cannot accept any registrations for learners under 18.
3 Delivering the qualification

Initial assessment and induction
An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs,
- support and guidance they may need when working towards their qualification.
- any units they have already completed, or credit they have accumulated which is relevant to the qualification.
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the learner fully understands the requirements of the qualification, their responsibilities as a learner, and the responsibilities of the centre. This information can be recorded on a learning contract.

Support materials
The following resources are available for this qualification:

<table>
<thead>
<tr>
<th>Description</th>
<th>How to access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample exam questions</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>Assignment guide</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>Sample schemes of work</td>
<td><a href="http://www.smartscreen.co.uk">www.smartscreen.co.uk</a></td>
</tr>
<tr>
<td>Further reading /links</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>Equipment lists</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>Recognition lists</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
</tbody>
</table>
4 Assessment

City & Guilds has written the following assessments to use with this qualification:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Assessment method</th>
<th>Where to obtain assessment materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>422</td>
<td>Personal and Professional Development</td>
<td>Assignment set by City &amp; Guilds, internally marked, externally verified</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>439</td>
<td>Applied Mathematics for Civil Engineering</td>
<td>Dated entry written exam paper</td>
<td>Question papers ordered via Walled Garden</td>
</tr>
<tr>
<td>440</td>
<td>Site Surveying</td>
<td>Assignment set by City &amp; Guilds, internally marked, externally verified Assignment</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>441</td>
<td>Structural Mechanics</td>
<td>Dated entry written exam paper</td>
<td>Question papers ordered via Walled Garden</td>
</tr>
<tr>
<td>442</td>
<td>Geotechnics and Soil Mechanics</td>
<td>Dated entry written exam paper</td>
<td>Question papers ordered via Walled Garden</td>
</tr>
<tr>
<td>443</td>
<td>Materials for Civil Engineering</td>
<td>Dated entry written exam paper</td>
<td>Question papers ordered via Walled Garden</td>
</tr>
<tr>
<td>444</td>
<td>Hydraulics in Civil Engineering</td>
<td>Dated entry written exam paper</td>
<td>Question papers ordered via Walled Garden</td>
</tr>
<tr>
<td>445</td>
<td>Highway Engineering</td>
<td>Dated entry written exam paper</td>
<td>Question papers ordered via Walled Garden</td>
</tr>
<tr>
<td>Unit</td>
<td>Title</td>
<td>Assessment method</td>
<td>Where to obtain assessment materials</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>446</td>
<td>Communications, Manual Drafting and CAD for Engineers</td>
<td>Assignment set by City &amp; Guilds, internally marked, externally verified Assignment</td>
<td><a href="http://www.cityandguilds.com">www.cityandguilds.com</a></td>
</tr>
<tr>
<td>447</td>
<td>Civil Engineering Construction Techniques</td>
<td>Dated entry written exam paper</td>
<td>Question papers ordered via Walled Garden</td>
</tr>
</tbody>
</table>
Test specifications

The way the knowledge is covered by each test is laid out in the tables below:

**Test 1:** Unit 439  Applied Mathematics for Civil Engineering  
**Duration:** 3 hours  
**Grading:** Pass/Merit/Distinction

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Be able to use algebraic methods to analyse and solve civil engineering problems</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2 Be able to solve civil engineering problems using trigonometry</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>3 Be able to use differential and integral calculus to solve civil engineering problems</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>4 Be able to use statistical concepts to describe data</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>5 Be able to apply probability techniques to solve civil engineering problems</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Test 2:** Unit 441  Structural Mechanics  
**Duration:** 3 hours  
**Grading:** Pass/Merit/Distinction

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Be able to determine reactions and forces, bending moments, shear forces and deflections</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>2 Be able to design simple beams and columns</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>3 Be able to calculate pressures and factors of safety on retaining walls</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
### Test 3: Unit 442 Geotechnics and Soil Mechanics

**Duration:** 3 hours  
**Grading:** Pass/Merit/Distinction

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Understand common rock types, their formation and use</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2 Understand the properties of soil</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>3 Be able to analyse the shear strength of soils and the mechanics of cohesion</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>4 Understand the basic principles of soil compaction and consolidation</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### Test 4: Unit 443 Materials for Civil Engineering

**Duration:** 2 hours  
**Grading:** Pass/Merit/Distinction

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Know the materials used in civil engineering</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2 Understand how the physical properties of civil engineering materials affect their use</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>3 Understand how civil engineering materials are protected from deterioration and failure in use</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
### Test 5: Unit 444 Hydraulics for Civil Engineering

**Duration:** 3 hours  
**Grading:** Pass/Merit/Distinction

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Understand static and dynamic fluids</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2 Understand the principles of fluid flow in pipes and channels</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>3 Be able to design pipe networks</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>4 Understand the characteristics of pumps</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### Test 6: Unit 445 Highway Engineering

**Duration:** 3 hours  
**Grading:** Pass/Merit/Distinction

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Be able to design the alignment of a highway</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>2 Understand the principles of pavement design</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>3 Understand the principles of highway lighting</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>4 Understand the principles of highway drainage</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Test 7: Unit 447 Civil Engineering Construction Techniques
Duration: 3 hours
Grading: Pass/Merit/Distinction

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number of marks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Understand the techniques and resources used to construct earthworks</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>2 Understand the techniques used to construct substructures</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>3 Understand the techniques used to construct superstructures</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>4 Understand the techniques used to construct infrastructure</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Time constraints

The following time constraints must be applied to the assessments of this qualification:

- each assignment has suggested durations; please refer to the individual assignments and to the Assessor Guidance. Centre staff should guide learners to ensure excessive evidence gathering is avoided. Centres finding that assignments are taking longer, should contact the External Quality Assurer for guidance.
- all assignments must be completed and assessed within the learner’s period of registration. Centres should advise learners of any internal timescales for the completion and marking of individual assignments.
- all dated entry written exam papers must be sat within the learner’s period of registration.

Assessment strategy

City & Guilds provide sample questions for each unit assessed by dated entry written exam paper.

The purpose of these sample questions is to provide examples of the type of question that will be set, giving an indication of the breadth and depth of knowledge that is expected. It should be noted that these are sample questions and not a full sample question paper.

Dated entry examinations will take place in June and December, with the first exam series in June 2015.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification.

RPL is not allowed for this qualification.
5 Grade profile

Purpose and use of this qualification grade profile
City & Guilds has taken the decision to grade the individual assessments included in this qualification, and provide a grade associated with each unit. This decision is based on market research with employers and colleges that suggests grading can be of use both as a motivational tool within the learning environment, and also to learners presenting evidence of their skills to prospective employers.
For this reason, the tasks have been developed to extend learners beyond the minimum required for Pass. As a basis for developing the tasks and their related grading criteria, City & Guilds consulted a number of stakeholders to discover what the grades at each level should mean in practice, and how they might be used. The following descriptors are based on that consultation.
The descriptors were used in the development of the task grading criteria and should be used by assessors to understand the intended outcomes of the grading.
They should be referred to during the centre’s standardising exercises in addition to the specific grading criteria for the unit to support a consistent understanding of the standard across units, centres and assessors. The grades achieved by a learner would be considered by universities for subsequent entry into the correct year of a degree programme.

Levels
Level 4
The Level 4 Diplomas in Civil Engineering focus on advanced engineering. The learners will have the potential to fulfil a role within Engineering that requires a high level of responsibility, for example within first level management, requiring the use of personal initiative and critical judgement.

Holders of these qualifications may also be able to advance into the second year of a selected university engineering degree programme.

Level 5
The Level 5 Diplomas in Civil Engineering focus on advanced engineering. The learner will have the potential to fulfil a role within Engineering that requires a high level of responsibility, for example leading to middle management and/or project management, requiring the use of personal initiative and critical judgement.

Holders of these qualifications may also be able to advance into the third year of a selected university engineering degree programme.

To take this qualification a learner must first achieve the 9209 Level 4 Diploma in Civil Engineering.

Delivery of learning
Learning is delivered by approved colleges and training providers in simulated learning environments, not in the workplace. Learners will however have access to real work environments in which to further develop the breadth of their skills and their experience.
**Grading**

The majority of tasks are graded Pass / Merit / Distinction. Pass reflects the minimum requirements that are expressed in the unit, with Merit and Distinction showing progression in skills and knowledge as well as recognising behaviours important to the industry.

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 4</strong></td>
<td><strong>Learner:</strong></td>
<td><strong>Learner:</strong></td>
</tr>
<tr>
<td></td>
<td>Capable of making informed decisions, likely to have achieved a grade at Level 3 (Merit / Distinction), starting to have sufficient skills to bring value to the industry, is becoming comfortable with occupational systems and procedures.</td>
<td>Broader understanding of systems and procedures, can work with minimal guidance, determination to resolve issues, taking ownership and responsibility for own learning, desire to progress.</td>
</tr>
<tr>
<td><strong>Evidence:</strong></td>
<td>Complex tasks may present some challenge, partial attempt at assessment, well defined tasks completed with a level of guidance, able to follow the required process, acceptable skills / knowledge / competence displayed for the industry, can plan, can solve problems. Limited reflection on the outcomes of the task.</td>
<td>Full attempt at assessment, well defined tasks completed with minimal guidance, able to follow the required process, higher level skills / knowledge / competence displayed for the industry, can plan, can solve problems more effectively and confidently. Sufficient reflection on the outcomes of the task.</td>
</tr>
<tr>
<td>Level 5</td>
<td>Pass</td>
<td>Merit</td>
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<tr>
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</tr>
<tr>
<td><strong>Learner:</strong></td>
<td>Capable of making informed decisions, likely to have achieved a grade at Level 4 (Merit / Distinction), has sufficient skills to bring value to the industry, is fairly comfortable with occupational systems and procedures.</td>
<td>Learner: Full understanding of systems and procedures, can work with minimal to no guidance, determination to resolve issues, taking ownership and responsibility for own learning, desire to excel.</td>
</tr>
<tr>
<td><strong>Evidence:</strong></td>
<td>Complex tasks may present some challenge, but most assessments attempted, well defined tasks completed with a level of guidance, able to follow the required process, acceptable skills / knowledge / competence displayed for the industry, can plan, can solve problems. Satisfactory reflection on the outcomes of the task.</td>
<td>Evidence: Full attempt at assessment, well defined tasks completed with minimal guidance, able to follow the required process, higher level skills / knowledge / competence displayed for the industry, can plan, can solve problems more effectively and confidently. Good reflection on the outcomes of the task.</td>
</tr>
</tbody>
</table>
6 Units

Structure of units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours
- notional learning hours
- unit aim
- information on assessment
- learning outcomes which are comprised of a number of assessment criteria
- notes for guidance.
Unit 422  Personal and Professional Development

Level: 4  
UAN: A/506/9305  
GLH: 25  
Assessment method: Assignment

Aim: The purpose of this unit is to enable learners to develop an understanding of the different methods and resources available to them for planning their personal and professional development.

They will learn how to identify factors that may affect targets or goals, prioritise actions and understand how feedback from others can be utilised to aid their development and career progression. They will be able to develop a plan which can either be used during progress of a course of study or as a tool in their future careers.

Learning outcome

The learner will:
1. understand how to plan for personal and professional development

Assessment criteria

The learner can:
1.1 describe the benefits of personal and professional development  
1.2 identify development opportunities for career and personal progression  
1.3 analyse development opportunities that may support career and personal progression.
<table>
<thead>
<tr>
<th>Range</th>
<th></th>
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</thead>
</table>
| **Benefits** | personal - update skills, gain new skills, increase motivation, confidence  
professional - career progression, meeting organisation goals, how role fits into organisation |
| **Development opportunities** |  |
| - internal and external  
- skills: inter-personal, enterprise, self-management and leadership  
- knowledge: qualifications |

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th></th>
</tr>
</thead>
</table>
| The learner will:  
2. understand how people learn |

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th></th>
</tr>
</thead>
</table>
| The learner can:  
2.1 explain the principles of how people learn  
2.2 describe different learning styles  
2.3 evaluate learning resources to support development  
2.4 analyse the use of different learning strategies. |

<table>
<thead>
<tr>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td><strong>Principles</strong></td>
<td>relevant theories, methodologies, pedagogies, codes of ethics</td>
</tr>
<tr>
<td><strong>Learning styles</strong></td>
<td>visual, aural, physical, logical, social, solitary</td>
</tr>
<tr>
<td><strong>Learning resources</strong></td>
<td>libraries; organisation's resources, IT, internet, progress files, portfolio development</td>
</tr>
<tr>
<td><strong>Learning strategies</strong></td>
<td>awareness of personal style e.g. activist, pragmatist, theorist, reflector, interactions with others, taking responsibility for own development, effective time-management, structured reflection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th></th>
</tr>
</thead>
</table>
| The learner will:  
3. be able to produce personal and professional development plans |

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th></th>
</tr>
</thead>
</table>
| The learner can:  
3.1 carry out self-audit of skills and experience  
3.2 identify targets for personal and professional development  
3.3 use methods to track personal development  
3.4 create a personal and professional development plan. |
<table>
<thead>
<tr>
<th>Range</th>
</tr>
</thead>
</table>
| **Self-audit**  
personal reflections, feedback from others; skills scan; revisiting job role |
| **Targets**  
SMART target setting, responding to feedback, realigning targets, addressing strengths and weaknesses |
| **Methods**  
task manager, blog, project management tools, diaries, performance review/plan, objectives, monitoring, reflecting and planning |

<table>
<thead>
<tr>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner will:</td>
</tr>
<tr>
<td>4. be able to make recommendations for personal and professional development</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner can:</td>
</tr>
<tr>
<td>4.1 explain the <strong>benefits</strong> of reflective practice</td>
</tr>
<tr>
<td>4.2 evaluate <strong>progress</strong> against development plan</td>
</tr>
<tr>
<td>4.3 recommend opportunities for further development.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Range</th>
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</thead>
</table>
| **Benefits**  
extent to which targets have been met/not met, recognise any changes in expectations; suggest further support required, identify barriers to progress |
| **Progress**  
the learner should regularly identify progress against original plan and refine plan accordingly |
Unit 439  Applied Mathematics for Civil Engineering

Level: 4
UAN: R/506/9181
GLH: 60
Assessment method: Dated written paper

Aim: The purpose of this unit is to enable learners to develop an understanding of a range of mathematical operations and analysis techniques that are required to solve engineering problems.

On completion of this unit, learners will be able to:
- apply algebraic methods to analyse and solve civil engineering problems
- apply trigonometric methods of analysis to solve civil engineering problems
- apply differential and integral calculus methods to solve civil engineering problems
- apply statistical techniques to solve civil engineering problems
- apply probability techniques to solve civil engineering problems

Learning outcome
The learner will:
1. be able to use algebraic methods to analyse and solve civil engineering problems

Assessment criteria
The learner can
1.1 evaluate basic algebraic functions
1.2 solve engineering problems that are described by algebraic equations, exponential and logarithmic functions.
<table>
<thead>
<tr>
<th><strong>Range</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic algebraic functions</strong></td>
</tr>
<tr>
<td>algebraic functions (graph of a function, inverse of a function, odd and even functions, linear functions, gradient of a linear function, points of intersection); common engineering functions (polynomial, rational, modulus, unit step, unit impulse); use of symbols; indices (positive and negative); laws of indices; algebraic formulae (transposition, factorisation, evaluation of algebraic fractions)</td>
</tr>
<tr>
<td><strong>Algebraic equations, exponential and logarithmic functions</strong></td>
</tr>
<tr>
<td>linear equations; quadratic equations; polynomial equations; simultaneous equations; solving inequalities; partial fractions</td>
</tr>
<tr>
<td><strong>Exponential and logarithmic functions</strong></td>
</tr>
<tr>
<td>laws of logarithms; solving exponential and logarithmic equations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Learning outcome</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner will:</td>
</tr>
<tr>
<td>2. be able to solve civil engineering problems using trigonometry</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Assessment criteria</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner can:</td>
</tr>
<tr>
<td>2.1 evaluate <a href="#">basic trigonometric functions</a></td>
</tr>
<tr>
<td>2.2 solve problems using <a href="#">trigonometric identities</a></td>
</tr>
<tr>
<td>2.3 solve problems using <a href="#">vector analysis</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Range</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic trigonometric functions</strong></td>
</tr>
<tr>
<td>angles; sine; cosine; tangent; secant; cosecant; cotangent of an angle; inverse functions; sin(^{-1}); cos(^{-1}); tan(^{-1}); trigonometric functions and their graphs; amplitude; frequency; phase and period of a sine or cosine function</td>
</tr>
<tr>
<td><strong>Trigonometric identities</strong></td>
</tr>
<tr>
<td>compound and double angle formulae for sine and cosine; ‘sums to product’ and ‘product to sums’ formulae; solve trigonometric equations; application to resolution and resultant of forces</td>
</tr>
<tr>
<td><strong>Vector analysis</strong></td>
</tr>
<tr>
<td>scalar and vector quantities; scalar and vector product of two vectors; angle between two vectors; static forces, frameworks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Learning outcome</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner will:</td>
</tr>
<tr>
<td>3. be able to use differential and integral calculus to solve civil engineering problems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Assessment criteria</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner can:</td>
</tr>
<tr>
<td>3.1 determine first and higher order derivatives of <a href="#">functions</a></td>
</tr>
<tr>
<td>3.2 use <a href="#">differential calculus</a> to solve problems</td>
</tr>
<tr>
<td>3.3 determine indefinite and definite <a href="#">integrals</a> of algebraic and trigonometric functions and differential equations</td>
</tr>
<tr>
<td>3.4 use <a href="#">integral calculus</a> to solve problems.</td>
</tr>
<tr>
<td>Range</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>Differential calculus</td>
</tr>
<tr>
<td>Integrals</td>
</tr>
<tr>
<td>Integral calculus</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th>The learner will:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>be able to use statistical concepts to describe data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th>The learner can:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>present data in appropriate forms</td>
</tr>
<tr>
<td>4.2</td>
<td>apply statistics to describe data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Range</th>
<th>Forms</th>
<th>data presentation: bar charts, tally charts, line diagrams, histograms, cumulative frequency diagrams, scatter plots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>concept of central tendency to include mean, median and mode; dispersion to include standard deviation, variance, interquartile range of grouped data, normal distribution.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th>The learner will:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>be able to apply probability techniques to solve civil engineering problems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th>The learner can:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>use probability to solve problems.</td>
</tr>
</tbody>
</table>

| Range        | Probability       | empirical probability, mutually exclusive and non-exclusive events, conditional probability, discrete probability distribution, permutations and combinations, general binomial distribution, normal distribution  |
# Unit 440  Site Surveying

<table>
<thead>
<tr>
<th>Level:</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAN:</td>
<td>Y/506/9182</td>
</tr>
<tr>
<td>GLH:</td>
<td>60</td>
</tr>
<tr>
<td>Assessment method:</td>
<td>Assignment</td>
</tr>
</tbody>
</table>

## Aim:
The purpose of this unit is to enable learners to develop an understanding of the principles of site surveying and the production of drawings and the skills to use site surveying instruments.

In addition, learners will also gain an understanding of the procedures used to set out civil engineering works alongside an appreciation of the use of surveying instruments.

## Learning outcome
The learner will:

1. know how to use linear surveying equipment to produce drawings to scale

## Assessment criteria
The learner can:

1.1 define **linear surveying terminology**
1.2 describe the **equipment** used to complete linear surveys.

## Range

**Linear surveying terminology**
chainage, running measurements, offsets, tie lines, check lines, sloping ground measurements, linear measurements around obstructions, triangulation, trilateration, grid, intersection

**Equipment**
tapes, bands, ranging poles, chains, Electronic Distance Measurement (EDM)
### Learning outcome
The learner will:

2. be able to use linear surveying equipment to produce drawings to scale

### Assessment criteria
The learner can:

2.1 perform linear surveys
2.2 produce **plan drawings** from practical linear surveys.

### Range
**Plan drawings**
to scale, standard conventions, manually drafted or by Computer-Aided Design (CAD)

---

### Learning outcome
The learner will:

3. know how to use levelling instruments

### Assessment criteria
The learner can:

3.1 define **levelling surveying terminology**
3.2 describe **equipment** used to complete a level survey
3.3 explain **accuracy checks** for levelling surveys.

### Range
**Levelling surveying terminology**
back sight, fore sight, intermediate sight, datum, Ordnance Bench Mark (OBM), Temporary Bench Mark (TBM), height of collimation, rise and fall, flying levels

**Equipment**
automatic levels, tilting levels, rotating lasers

**Accuracy checks**
for common errors, relationship between scale of plan and measurement accuracy, temporary and permanent adjustments

---

### Learning outcome
The learner will:

4. be able to use levelling equipment

### Assessment criteria
The learner can:

4.1 complete levelling surveys using **booking methods**
4.2 produce **section drawings** from completed levelling surveys.
### Range

**Booking methods**
height of collimation or rise and fall methods

**Section drawings**
longitudinal section and cross sections

### Learning outcome

The learner will:
5. know how to use angular measuring instruments

### Assessment criteria

The learner can:
5.1 define angular surveying **terminology**
5.2 describe **equipment** used to perform angular measurements
5.3 explain the **errors** which can occur when recording angles
5.4 explain **how errors may be reduced** to improve the accuracy of recorded angular measurements.

### Range

**Terminology**
azimuth, zenith angles, Whole Circle Bearing (WCB), horizontal angle, angles of elevation and depression

**Equipment**
Theodolites, total station, data loggers, Electronic Distance Measurement (EDM)

**Errors**
common errors, principles of good intersection of lines of sight, increasing distance and link to angular error

**How errors may be reduced**
error analysis and least square method, Bowditch method of correction of closure error in a traverse

### Learning outcome

The learner will:
6. be able to use angular measuring instruments

### Assessment criteria

The learner can:
6.1 **measure** horizontal angles
6.2 calculate height and distances from recorded angular **measurements** using trigonometry.

### Range

**Measure**
face left, face right booking procedure to record angles

**Measurements**
Pythagoras theorem, sine rule; cosine rule
Learning outcome
The learner will:
7. understand the principles of setting out construction projects

Assessment criteria
The learner can:
7.1 describe the procedures used to set out a domestic building
7.2 describe the procedures used to set sight rails, and gradients
7.3 describe the procedures used to set out and level foundations.

Range
Procedures used to set out a domestic building
3:4:5 triangles, checking diagonals, corner profiles

Procedures used to set sight rails, and gradients
transfer of datum, set out pegs, sight rails
### Unit 441  Structural Mechanics

**Level:** 4  
**UAN:** D/506/9183  
**GLH:** 60  
**Assessment method:** Dated written paper

**Aim:** This unit enables learners to develop an understanding of the analysis of beams, columns, frameworks and retaining walls structural concepts and develop skills to determine properties of typical structure materials.

#### Learning outcome
The learner will:
1. be able to determine reactions and forces, bending moments, shear forces and deflections

#### Assessment criteria
The learner can:
1.1 calculate reactions, shear force and bending moment values for various loadings on beams  
1.2 draw diagrams for various loadings  
1.3 calculate deflections at mid-span for simply supported beams  
1.4 draw associated shear force and bending moment diagrams for a three element pin-jointed frame  
1.5 determine the magnitude and type of forces in frameworks using a range of methods and loading conditions.

#### Range
**Beams**  
simply supported beams with/without overhangs, cantilevers

**Diagrams**  
shear force, bending moment

**Loadings**  
point, uniformly distributed, combination of loads

**Range of methods**  
graphical (Bow’s notation), method of sections (frame cutting, equilibrium of part frame), method of resolution (joint equilibrium)
Learning outcome
The learner will:
1. be able to design simple beams and columns

Assessment criteria
The learner can:
1. calculate first and second moments of area of sections of sections
2. determine the size of rectangular beam sections
3. determine the section sizes for axially loaded columns.

Range
Sections
rectangular, circular, trapezoidal, compound shapes
Beam sections
rectangular, T, I and channel
Beam
steel, timber, concrete
Columns
Type: short/long columns, section (solid, rectangular, H section, circular)
Columns
steel, timber, concrete

Learning outcome
The learner will:
3. be able to calculate pressures and factors of safety on retaining walls

Assessment criteria
The learner can:
3.1 calculate the pressure on retaining walls
3.2 determine factors of safety against sliding and overturning
3.3 calculate the stress conditions at the toe and heel of a retaining wall.

Range
Pressure
from retained soils and liquids
Walls
types - mass (rectangular and trapezoidal)
Unit 442  Geotechnics and Soil Mechanics

<table>
<thead>
<tr>
<th>Level:</th>
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<tbody>
<tr>
<td>UAN:</td>
<td>H/506/9248</td>
</tr>
<tr>
<td>GLH:</td>
<td>60</td>
</tr>
<tr>
<td>Assessment method:</td>
<td>Dated written paper</td>
</tr>
</tbody>
</table>

Aim: This unit enables learners to develop an understanding of common rock types and their use in civil engineering. Learners will analyse the properties and characteristics of different types of soil using standard tests, and apply the knowledge and understanding obtained to the design of earthworks, excavations and foundations.

### Learning outcome
The learner will:
1. understand common rock types, their formation and use

### Assessment criteria
The learner can:
1.1 describe the classification of rock types
1.2 describe common rock forming minerals including their mode of formation
1.3 describe features of geological maps
1.4 explain the structural implications of geological maps in foundation design.

### Range
**Rock**
igneous (granite, basalt, dolerite, andesite, gabbro, rhyolite, syenite), sedimentary (limestone, sandstone, mudstone, shale, conglomerate), metamorphic (slate, schist)

**Minerals**
(rock forming) quartz, mica, feldspars, calcite

**Features**
bedding, dip, strike, cline, fold, faults, slip, settlement, drift

**Structural implications**
difficulty of excavation, fragmentation
Learning outcome
The learner will:
2. understand the properties of soil

Assessment criteria
The learner can:
2.1 describe soil classification methods
2.2 explain soil properties
2.3 describe the nature of drained and undrained soil stresses
2.4 describe the movement of water through soils
2.5 describe methods of site investigation
2.6 explain the mechanics of soil friction and cohesion
2.7 describe how to determine the shear strength of soils using tests
2.8 explain the shear strength of soils.

Range
Soil classification methods
particle size analysis, consistency limits, plasticity indices
Soil properties
dry, bulk, saturated and submerged densities, void ratio, porosity, moisture content, liquid limit, degree of saturation, permeability, specific gravity
Soil stresses
pressure (total, effective, neutral), definitions and calculations for Movement of water
soil permeability, hydraulic gradient
Methods
trial pits, hand auger, rotary boring, percussion rig boring
Tests
shear box, triaxial compression
Explain
importance of shear strength, Mohr’s circles, shear failure for various soil types, shear strength envelope, shear testing with different drainage conditions

Learning outcome
The learner will:
3. be able to analyse the shear strength of soils and the mechanics of cohesion

Assessment criteria
The learner can:
3.1 establish basic engineering properties of soils using either primary or secondary data
3.2 determine total stress
3.3 calculate stresses.
### Properties of soil
- dry, bulk, saturated and submerged densities, void ratio, porosity, moisture content, liquid limit, degree of saturation, permeability, specific gravity

### Total stress
- effective stress, and hydrostatic pore pressure for ground conditions

### Stresses
- incline planes, general two dimensional systems, direct/shear stress on any plane, principal plane stresses, maximum shear stress

### Learning outcome
The learner will:
4. understand the basic principles of soil compaction and consolidation

### Assessment criteria
The learner can:
4.1 compare soil compaction and consolidation
4.2 explain the basic principles of soil consolidation
4.3 describe the nature of lateral pressure which can exist within a soil mass
4.4 determine the pressure on retaining walls due to liquid and active earth pressure
4.5 calculate factors of safety of retaining walls.

### Lateral pressure
- Rankine theory of pressures, Coulomb wedge theory, methods of calculating lateral forces on a structure, influence of ground water.
Level: 4
UAN: K/506/9249
GLH: 60
Assessment method: Dated written paper

Aim: The purpose of this unit is to enable learners to develop an understanding of the materials used in civil engineering, their properties and uses, the causes of failure of such materials and the methods used to prevent failure.

### Learning outcome
The learner will:
1. know the materials used in civil engineering

### Assessment criteria
The learner can:
1.1 identify the materials used in civil engineering
1.2 describe how civil engineering materials are manufactured from naturally-occurring raw ingredients
1.3 describe the tests performed on civil engineering materials.

### Range
#### Materials
Metals, timber, concrete, polymers, bricks and blocks

#### Raw ingredients
Metallic ores; clay, limestone/chalk, aggregates; oil; clay or sand/lime

#### Tests
Strength (compressive, tensile, shear, flexural), moisture content, workability

### Learning outcome
The learner will:
2. understand how the physical properties of civil engineering materials affect their use

### Assessment criteria
The learner can:
2.1 describe the physical properties of civil engineering materials
2.2 explain how the properties of civil engineering materials affect their use.
### Range

**Physical properties**
strength, elasticity, porosity, water absorption, thermal movement, moisture movement, durability, workability, density

**Use**
resistance to loads, water and other forms of chemical and physical degradation, durability, ease of installation, relative costs, implications for sustainability and the environment

<table>
<thead>
<tr>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner will:</td>
</tr>
<tr>
<td>3. understand how civil engineering materials are protected from deterioration and failure in use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner can:</td>
</tr>
<tr>
<td>3.1 explain the <strong>mechanisms</strong> by which civil engineering materials deteriorate and fail in use</td>
</tr>
<tr>
<td>3.2 justify the <strong>methods</strong> used to protect civil engineering materials.</td>
</tr>
</tbody>
</table>

### Range

**Mechanisms**
over-loading, corrosion, fatigue, creep, fungal and insect attack, sulphate attack, ultra-violet (UV) attack, efflorescence

**Methods**
selection of resistant materials; appropriate design solutions for the exclusion of water, treatment of materials including preservation of timber, use of sulphur-resistant cement in concrete and anti-corrosion measures for metals
Unit 444  Hydraulics in Civil Engineering

Level: 4
UAN: D/506/9250
GLH: 60
Assessment method: Dated written paper

Aim: The aim of this unit is to develop the learner’s understanding of the concepts, theory and application of hydraulics and establish their relevance in civil engineering.

This unit will enable learners to demonstrate and explore key hydraulics phenomena and investigate the design of pipe networks, the characteristics of flow in open channels and the types and operation of pumps.

Learning outcome
The learner will:
1. understand static and dynamic fluids

Assessment criteria
The learner can:
1.1 describe the properties of fluids
1.2 explain how pressure acts on submerged bodies in fluids
1.3 determine centres of pressure
1.4 explain buoyancy and stability of floating bodies.

Range
Properties of fluids
density, viscosity, surface tension, compressibility, hydrostatic pressure, static pressure and head, pressure at a point

Pressure
hydrostatic vertical pressure distribution, pressures at equal depth, pressure at a point, forces acting at boundaries

Centres of pressure
immersed planes (inclined and vertical)

Buoyancy and stability
metacentric height, centre of gravity, Archimedes’ Principle
Learning outcome
The learner will:
2. understand the principles of fluid flow in pipes and channels

Assessment criteria
The learner can:
2.1 explain the continuity equation and Bernoulli’s energy equations
2.2 explain the principles of momentum
2.3 explain flow measurement methods in pipes and channels
2.4 explain the characteristics of open channel flow.

Range
Flow measurement methods
orifice plates, venture meters, venturi flumes, weirs, pitot tubes

Characteristics
types of flow, steady, uniform and varied, gradually varied flow, rise in bed level, flow resistance

Learning outcome
The learner will:
3. be able to design pipe networks

Assessment criteria
The learner can:
3.1 carry out risk assessments
3.2 mitigate risks before carrying out experiments
3.3 determine losses in pipelines
3.4 design pipe networks
3.5 perform calculations relating to flow in open channels.

Range
Losses in pipelines
major losses (energy) and minor losses (others)

Design
D’Arcy-Weisbach theory, Moody diagrams, pie design charts

Flow in open channels
Velocity and discharge calculations, rectangular and trapezoidal channels, normal and critical depths, D’Arcy, Chezy and Manning equations, functions of weirs

Learning outcome
The learner will:
4. understand the characteristics of pumps

Assessment criteria
The learner can:
4.1 describe types of pumps
4.2 explain the performance curves of pumps
4.3 explain the operation of pumps.
<table>
<thead>
<tr>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Types of pumps</strong></td>
</tr>
<tr>
<td>rotodynamic and hydrostatic pumps, pumps in parallel and in series</td>
</tr>
<tr>
<td><strong>Operation of pumps</strong></td>
</tr>
<tr>
<td>pump resistance, pump choice</td>
</tr>
</tbody>
</table>
Unit 445  Highway Engineering

Level: 4
UAN: H/506/9251
GLH: 60
Assessment method: Dated written paper

Aim: The purpose of this unit is to enable learners to develop an understanding of the key issues considered in designing highways. Learners will be able to design the alignment of highways that are safe and which take into account lighting and drainage requirements.

Learning outcome
The learner will:
1. be able to design the alignment of a highway

Assessment criteria
The learner can:
1.1 determine the visibility requirements for a highway
1.2 design the vertical alignment of a highway to relevant national standards to ensure safety
1.3 design the horizontal alignment of highway sections to relevant national standards to ensure safety.

Range
Visibility
Stopping Sight Distance; Full Overtaking Sight Distance
Vertical alignment
radii and curve lengths for sag and crest curves; visibility checks
Horizontal alignment
radii of circular curves including superelevated curves; transition curves; visibility checks; offsets

Learning outcome
The learner will:
2. understand the principles of pavement design

Assessment criteria
The learner can:
2.1 explain the functions of pavement layers
2.2 explain the importance of ground conditions on pavement design
2.3 compare pavement types
2.4 explain the effect of design traffic on pavement design.
**Range**

**Functions**
skid resistance; smooth running surface; distribution of loads to lower layers and subgrade; drainage

**Pavement types**
jointed Reinforced Concrete Pavements, Continuously Reinforced Concrete Pavements/Roadbases; Flexible; Flexible Composite Pavements

**Design traffic**
loading of standard axles over lifespan of the pavement

---

**Learning outcome**
The learner will:
3. understand the principles of highway lighting

**Assessment criteria**
The learner can:
3.1 explain **methods** of discerning hazards and features on highways
3.2 describe the **purpose** of highway lighting
3.3 describe the **factors** determining the shape and size of a bright patch
3.4 compare different street lighting **arrangements**.

---

**Range**

**Methods**
Silhouette, reverse silhouette

**Purpose**
distinguish hazards; enable highway alignment to be perceived; improved safety

**Factors**
mounting height, lamp type, lantern type, pavement surface, weather conditions

**Arrangements**
single sided, staggered, opposite, high mast, span wire

---

**Learning outcome**
The learner will:
4. understand the principles of highway drainage

**Assessment criteria**
The learner can:
4.1 describe **drainage systems**
4.2 explain the **factors** that influence how pipe diameter and gradients are selected.

---

**Range**

**Drainage systems**
French/filter drains; positive drainage; open drainage

**Factors**: storm intensity; return period
Unit 446  Communications, Manual Drafting and CAD for Engineers

Level: 4
UAN: K/506/9252
GLH: 60
Assessment method: Assignment

Aim: This unit has two purposes. The first is to enable learners to develop an understanding of the methods used to communicate in civil engineering. This includes verbal and written communication methods (including presentational techniques) and the interpretation of civil engineering drawings, schedules and specifications. There is a strong emphasis on the correct use of technical language, grammar, spelling and punctuation. The second purpose is to develop an understanding of Computer Aided Design and Building Information Modelling (BIM) in civil engineering projects. Learners will be able to draw detailed scaled civil engineering structures using CAD.

<table>
<thead>
<tr>
<th>Learning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner will:</td>
</tr>
<tr>
<td>1. understand the range of communication methods used in civil engineering</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner can:</td>
</tr>
<tr>
<td>1.1 describe standard forms of contract</td>
</tr>
<tr>
<td>1.2 explain the purpose of information sources used in civil engineering</td>
</tr>
<tr>
<td>1.3 interpret civil engineering information from graphical sources.</td>
</tr>
</tbody>
</table>
### Range

#### Information sources
manuals, contracts, specifications, design standards

#### Graphical sources
sketches, working drawings, component drawings, maps, Global Positioning System (GPS), Geographic Information System (GIS), specifications

### Learning outcome
The learner will:
2. understand how to communicate effectively in the workplace

### Assessment criteria
The learner can:
2.1 explain the importance of **interpersonal and communication skills** in the optimisation of performance
2.2 evaluate the **effectiveness of feedback** when developing communication skills
2.3 assess **methods of communication** appropriate to different audiences.

### Range

#### Interpersonal and communication skills
written; verbal; visual; outcomes; key points; intonations; accuracy; urgency; level of importance; adaptation; audience; barriers; achieved purpose; formality; variety of situations

#### Effectiveness of feedback
analysis of formal and informal feedback; reflection

#### Methods of communication
written; verbal; visual; format; layout; presentation; objectives; discussion; adaptation

### Learning outcome
The learner will:
3. be able to communicate in civil engineering

### Assessment criteria
The learner can:
3.1 use effective speaking and listening skills in a civil engineering **context**
3.2 produce **written documents** to an **acceptable standard**.
Range

Context
meetings, interviews, presentations, team discussions, telephone conversations

Written documents
paper and electronic: reports, business letters, minutes of meetings, method statements, notices, presentations

Acceptable standard
clear and accurate use of technical language, grammar, spelling, punctuation

Learning outcome
The learner will:
4. be able to hand draw structures

Assessment criteria
The learner can:
4.1 sketch technical, scaled drawings of civil engineering structures in different projections
4.2 produce title blocks
4.3 sketch cross sections of structures
4.4 sketch detailed structural components.

Range

Structures
site plans; buildings; roads; bridges

Projections
isometric; first and third angle orthographic; single and multiple point perspective

Title blocks
to include: drawing title, drawing number, scale, units and notes

Components
steel reinforced concrete, I beams, floor slabs, beam and column joints, girders, foundations

Learning outcome
The learner will:
5. be able to produce technical drawings using CAD

Assessment criteria
The learner can:
5.1 sketch civil engineering structures in two dimensions
5.2 produce drawings using coordinate systems
5.3 create different line types
5.4 create layers for complex drawings
5.5 apply standard drawing tools
5.6 create and apply blocks
5.7 produce scaled pages with multiple viewports.
<table>
<thead>
<tr>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drawing tools</strong></td>
</tr>
<tr>
<td>line, polyline, circle, trim, extend, copy, offset, hatch, explode, mirror</td>
</tr>
</tbody>
</table>
# Unit 447
## Civil Engineering Construction Techniques

<table>
<thead>
<tr>
<th>Level:</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAN:</td>
<td>M/506/9253</td>
</tr>
<tr>
<td>GLH:</td>
<td>60</td>
</tr>
<tr>
<td>Assessment method:</td>
<td>Dated written paper</td>
</tr>
</tbody>
</table>

**Aim:**
The purpose of this unit is to enable learners to develop an understanding of the technology and resources associated with civil engineering projects including earthworks, substructures, superstructure and infrastructure.

**Learning outcome**
The learner will:
1. understand the techniques and resources used to construct earthworks

**Assessment criteria**
The learner can:
1.1 describe the techniques and resources used in earthworks
1.2 explain the techniques used to control groundwater
1.3 compare the earthmoving equipment used in earthworks
1.4 explain health and safety best practice to be followed when constructing earthworks.

**Range**

**Earthworks**
depth excavation, trenching works, stabilising ground, formation of slopes, cuttings and embankments

**Techniques**
sumps, wells, deep filters, wellpoints, electro-osmosis, French drains, ground freezing

**Equipment**
excavators, bulldozers, scrapers, tractor shovels, graders, transport vehicles

**Health and safety best practice**
risk assessments, method statements, compliance with relevant legislation (Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)
### Learning outcome

The learner will:

2. understand the techniques used to construct substructures

### Assessment criteria

The learner can:

2.1 describe the techniques and **resources** used in **substructure work**

2.2 explain the **factors** that affect the selection of suitable foundations

2.3 explain **health and safety best practice** to be followed when constructing substructures.

### Range

<table>
<thead>
<tr>
<th>Resources</th>
<th>Substructure work</th>
<th>Factors</th>
<th>Health and safety best practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>vehicles, plant, equipment</td>
<td>piling, stabilising ground, foundations, drainage, public utilities, culverts, underpasses</td>
<td>soil characteristics, water table, design loads, disposition of loads</td>
<td>risk assessments, method statements, compliance with relevant legislation (Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)</td>
</tr>
</tbody>
</table>

### Learning outcome

The learner will:

3. understand the techniques used to construct superstructures

### Assessment criteria

The learner can:

3.1 describe the techniques and **resources** used in **superstructure work**

3.2 explain how **construction techniques** influence the **design** of a structural framed building

3.3 explain **health and safety best practice** to be followed when constructing superstructures.

### Range

<table>
<thead>
<tr>
<th>Resources</th>
<th>Superstructure work</th>
<th>Construction techniques</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>vehicles, plant, equipment</td>
<td>bridges, retaining walls, steel and concrete framed buildings</td>
<td>Composite construction, pre-cast concrete, in-situ concrete, structural steel</td>
<td>Rectangular grid spacing, beams along grid lines, beam depth to span ratio, floor to ceiling heights, structural floors to limit deflection</td>
</tr>
</tbody>
</table>
Health and safety best practice
risk assessments, method statements, compliance with relevant legislation; Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)

Learning outcome
The learner will:
4. understand the techniques used to construct infrastructure

Assessment criteria
The learner can:
4.1 describe the techniques and resources used in infrastructure work
4.2 explain the construction of surface drainage of roads
4.3 explain health and safety best practice to be followed when constructing infrastructure.

Range
Resources
vehicles, plant, equipment
Infrastructure work
roads, rigid and flexible pavements, railways, ancillary works
Surface drainage
soakaways, filter drains, surface water channels, kerbs and gullies
Health and safety best practice
risk assessments, method statements, compliance with relevant legislation(Health and Safety at Work Act, Management of Health and Safety at Work Regulations, Construction Design and Management Regulations)
Appendix 1  Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the Centres and Training Providers homepage on www.cityandguilds.com.

Centre Guide – Delivering International Qualifications contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve ‘approved centre’ status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.
### Useful contacts

| **UK learners** | **T:** +44 (0)844 543 0033  
**General qualification information** | **E:** learnersupport@cityandguilds.com |
|-----------------|---------------------------------|---------------------------------------|
| **International learners** | **T:** +44 (0)844 543 0033  
**General qualification information** | **F:** +44 (0)20 7294 2413  
**E:** intcg@cityandguilds.com |
| **Centres** | **T:** +44 (0)844 543 0000  
**F:** +44 (0)20 7294 2413  
**E:** centresupport@cityandguilds.com |
| **Exams entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results** | **T:** +44 (0)844 543 0000  
**F:** +44 (0)20 7294 2413  
**F:** +44 (0)20 7294 2404 (BB forms)  
**E:** singlesubjects@cityandguilds.com |
| **Single subject qualifications** | **T:** +44 (0)844 543 0000  
**F:** +44 (0)20 7294 2413  
**E:** intops@cityandguilds.com |
| **International awards** | **T:** +44 (0)844 543 0000  
**F:** +44 (0)20 7294 2413  
**E:** intops@cityandguilds.com |
| **Walled Garden** | **T:** +44 (0)844 543 0000  
**F:** +44 (0)20 7294 2413  
**E:** walledgarden@cityandguilds.com |
| **Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems** | **T:** +44 (0)121 503 8993  
**E:** business@cityandguilds.com |
| **Employer** | **T:** +44 (0)844 543 0000  
**F:** +44 (0)20 7294 2413 |
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**F:** +44 (0)20 7294 2413 |
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**F:** +44 (0)20 7294 2413 |
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**F:** +44 (0)20 7294 2413 |

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