

# **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (720) (6720-36)**

November 2019 Version 2.2

**Qualification Handbook**

## Qualification at a glance

<b>Industry area</b>	Construction
<b>City &amp; Guilds qualification number</b>	6720-36
<b>Age group</b>	16-19 (Key Stage 5), 19+
<b>Entry requirements</b>	Centres must ensure that any pre-requisites stated in the <i>What is this qualification about?</i> section are met.
<b>Assessment</b>	<p>To gain this qualification, candidates must successfully achieve the following assessments:</p> <ul style="list-style-type: none"> <li>Two externally set, externally moderated assignments</li> <li>Two externally set, externally marked exams, sat under examination conditions</li> </ul>
<b>Additional requirements to gain this qualification</b>	Employer involvement in the delivery and/or assessment of this qualification is essential for all candidates and will be externally quality assured.
<b>Grading</b>	<p>This qualification is graded.</p> <p>For more information on grading, please see Section 7: Grading.</p>
<b>Approvals</b>	This qualification requires full centre and qualification approval
<b>Support materials</b>	<p>Sample assessments</p> <p>Guidance for delivery</p> <p>Guidance on use of marking grids</p>
<b>Registration and certification</b>	Registration and certification of this qualification is through the Walled Garden, and is subject to end dates.
<b>External quality assurance</b>	This qualification is externally quality assured by City & Guilds, and its internally marked assignments are subject to external moderation. There is no direct claim status available for this qualification.

Title and level	Size (GLH)	TQT	City & Guilds qualification number	Ofqual accreditation number
Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (720)	720	1200	6720-36	601/4508/0

Version and date	Change detail	Section
1.1 June 2016	Small typographical errors	Throughout
	TQT added for qualifications	1. Introduction
	Assessment component titles amended	
	Employer involvement guidance updated throughout	4. Employer involvement
	Summary of assessment methods and conditions	5. Assessment
	Moderation and standardisation of assessment updated throughout	6. Moderation and standardisation of assessment
	Awarding individual assessments	7. Grading
	Awarding grades and reporting results	
	Enquiries about results	8. Administration
	Re-sits and shelf-life of assessment results	
1.2 June 2017	Malpractice	
	Access arrangements and special consideration	
	City & Guilds Group statement updated	Useful contacts
	Addition of the examination paper based module number and removal of onscreen civil engineering assessment (050)	1. Introduction – Assessment requirements and employer involvement
		5. Assessment
		5. Assessment – exam Specification
		7. Grading – Awarding grades and reporting results
	Removal of AO 6-8 from Synoptic Assignments	5. Assessment – Assessment Objectives
	Revised Exam Specification, Exam Duration and AO weightings	5. Assessment – Exam Specification
	Addition of Provisional Grade Boundaries for the Synoptic Assignment	7. Grading
1.3 January 2018	Branding Changes	City and Guilds Logo
	Revised unit description (313)	1. What is this unit about
	Revised terminology error	2. Unit 313, Topic 3.2

1.4 February 2018	Revised topic description	1. Unit 308, Topic 1.4
1.5 March 2018	Added exam duration (048/548)	5. Assessment – Exam Specification
2.0 November 2018	Update to grading details and note added on restricted pathway to 1080 qualification.	Section 7 and Qualification Structure
2.1 May 2019	Wording changed regarding retakes	5. Assessment – Summary of assessment methods and conditions  8. Administration – Re-sits and shelf-life of assessment results
2.2 November 2019	Range added	Unit 304, Topic 2.3

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# 1 Introduction

## What is this qualification about?

The following purpose is for the **City & Guilds Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (720)**

Area	Description
OVERVIEW	
Who is this qualification for?	<p>This qualification is for you if you are 16 years or older and want to combine general education with learning in-depth theoretical aspects and practical activities related to the built environment sector. There are no specific entry requirements for this qualification.</p> <p>If you have ever wondered how the buildings, infrastructure and landscape around us come into existence, and would like to find out more, this qualification could be for you. This qualification could open up the world of the built environment sector, which covers all aspects of the creation of our towns and cities, and is fundamental to creating a sustainable future.</p>
What does this qualification cover?	<p>This two year part time qualification is split into <b>three</b> pathways: Construction, Design and Planning, and Civil Engineering. You will have a choice of which specialist pathway you study.</p> <p>You will study theoretical aspects of the subject and apply them to practical tasks.</p> <p>Compulsory topics for all pathways include:</p> <ul style="list-style-type: none"><li>• domestic construction technology</li><li>• industrial and commercial construction technology</li><li>• health and safety in the built environment</li><li>• construction science and materials</li><li>• graphical communication</li><li>• sustainability and new technologies</li><li>• mathematics for the built environment</li></ul> <p>For the 'Construction' pathway you will also take the following units:</p> <ul style="list-style-type: none"><li>• construction site supervision</li><li>• measurement, tendering and estimating</li><li>• site surveying</li><li>• property maintenance and conversion</li><li>• building regulations</li></ul>

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For the 'Design and Planning' pathway you will also take the following units:

- architectural design and planning
- property maintenance and conversion
- building surveying
- building regulations
- property management

For the 'Civil Engineering' pathway you will also take the following units:

- site surveying
- structural mechanics
- civil engineering technology
- building services technology
- further mathematics for the built environment

You will study both the practical use and knowledge of the subject, which may involve local employers providing real examples as part of the training. It is expected that you will visit or have visits from employers who can provide demonstrations and talks on the industry, which may also be a relevant work placement with an employer.

#### WHAT COULD THIS QUALIFICATION LEAD TO?

Will the qualification lead to employment, and if so, in which job role and at what level?

Depending on the pathway that you follow, the City & Guilds Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (720) could lead to employment opportunities for you as a:

- Construction Design Technician
- Construction Site Technician
- Civil Engineering Technician
- Construction Site Engineer
- Construction Work Supervisor
- Construction Site Supervisor
- Architectural Technician
- Building Surveyor

Why choose this qualification over similar qualifications?

City & Guilds offers four sizes of Level 3 qualification in Constructing the Built Environment: Certificate, Diploma (540), Extended Diploma (720) & Extended Diploma (1080).

You would take the Extended Diploma (720) if you want to specialise, to develop most of the skills and knowledge required by employers in the Construction industry. The Extended Diploma (720) is likely to be taken as a two year programme of study, alongside other qualifications such as AS or A Levels.

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Will the qualification lead to further learning?

When you have achieved this qualification you have a choice of seeking employment or going on to further learning, progressing on to qualifications such as:

- Construction Technician Apprenticeship
- Higher Apprenticeship in Construction Operations Management
- Higher Apprenticeship in Construction Management
- Foundation Degrees in the following areas: Construction and the Built Environment, Civil Engineering, Quantity Surveying, Building Surveying, Conservation and Restoration

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#### WHO SUPPORTS THIS QUALIFICATION?

Who supports this qualification?

This qualification is supported by the Chartered Institute of Building (CIOB).

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## Qualification structure

For the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Construction) (720)** the teaching programme must cover the content detailed in the structure below:

Unit number	Unit title	GLH
<b>Mandatory</b>		
301	Domestic construction technology	60
302	Industrial and commercial construction technology	60
303	Health and safety in the built environment	60
304	Construction site supervision	60
305	Construction science and materials	60
306	Measurement, tendering and estimating	60
307	Site surveying	60
311	Graphical communication	60
313	Property maintenance and conversion	60
316	Building regulations	60
317	Sustainability and new technologies	60
319	Mathematics for the built environment	60

For the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Design and Planning) (720)** the teaching programme must cover the content detailed in the structure below:

Unit number	Unit title	GLH
<b>Mandatory</b>		
301	Domestic construction technology	60
302	Industrial and commercial construction technology	60
303	Health and safety in the built environment	60
305	Construction science and materials	60
311	Graphical communication	60
312	Architectural design and planning	60
313	Property maintenance and conversion	60
314	Building surveying	60
316	Building regulations	60
317	Sustainability and new technologies	60
318	Property management	60

319	Mathematics for the built environment	60
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For the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Civil Engineering) (720)** the teaching programme must cover the content detailed in the structure below:

Unit number	Unit title	GLH
<b>Mandatory</b>		
301	Domestic construction technology	60
302	Industrial and commercial construction technology	60
303	Health and safety in the built environment	60
305	Construction science and materials	60
307	Site surveying	60
308	Structural mechanics	60
309	Civil engineering technology	60
310	Building services technology	60
311	Graphical communication	60
317	Sustainability and new technologies	60
319	Mathematics for the built environment	60
320	Further mathematics for the built environment	60

Please note that none of these pathways provide progression onto the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (1080) (6720-37)**.

## Total qualification time (TQT)

Total Qualification Time (TQT) is the total amount of time, in hours, expected to be spent by a Learner to achieve a qualification. It includes both guided learning hours (which are listed separately) and hours spent in preparation, study and assessment.

Title and level	GLH	TQT
Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (720)	720	1200

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## Assessment requirements and employer involvement

To achieve the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Construction) (720)** candidates must successfully complete **all** the mandatory assessment components.

Component number	Title
<b>Mandatory</b>	
040/540	Constructing the Built Environment – Theory exam
041	Constructing the Built Environment – Synoptic assignment
046/546	Constructing the Built Environment – Theory exam
047	Constructing the Built Environment – Synoptic assignment

To achieve the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Design and Planning) (720)** candidates must successfully complete **all** the mandatory assessment components.

Component number	Title
<b>Mandatory</b>	
040/540	Constructing the Built Environment – Theory exam
041	Constructing the Built Environment – Synoptic assignment
048/548	Constructing the Built Environment – Theory exam
049	Constructing the Built Environment – Synoptic assignment

To achieve the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Civil Engineering) (720)** candidates must successfully complete **all** the mandatory assessment components.

Component number	Title
<b>Mandatory</b>	
040/540	Constructing the Built Environment – Theory exam
041	Constructing the Built Environment – Synoptic assignment
550	Constructing the Built Environment – Theory exam
051	Constructing the Built Environment – Synoptic assignment

In addition, candidates **must** achieve the mandatory employer involvement requirement for this qualification **before** they can be awarded a qualification grade. For more information, please see guidance in *Section 4: Employer involvement*.

### Employer involvement

Component number	Title
<b>Mandatory</b>	
836	Employer involvement



## 2 Centre requirements

### Approval

New centres will need to gain centre approval. Existing centres who wish to offer this qualification must go through City & Guilds' **full** Qualification Approval Process. There is no fast track approval for this qualification. Please refer to the City & Guilds website for further information on the approval process: [www.cityandguilds.com](http://www.cityandguilds.com)

### Resource requirements

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

### Centre staffing

Staff delivering this qualification must be able to demonstrate that they meet the following requirements:

- be technically competent in the areas in which they are delivering
- be able to deliver across the breadth and depth of the content of the qualification being taught
- have recent relevant teaching and assessment experience in the specific area they will be teaching, or be working towards this
- demonstrate continuing CPD.

### Physical resources

Centres must be able to demonstrate that they have access to the equipment and technical resources required to deliver this qualification and its assessments.

### Internal Quality Assurance

Internal quality assurance is key to ensuring accuracy and consistency of tutors and markers. Internal Quality Assurers (IQAs) monitor the work of all tutors involved with a qualification to ensure they are applying standards consistently throughout assessment activities. IQAs must have, and maintain, an appropriate level of technical competence and be qualified to make both marking and quality assurance decisions through a teaching qualification or recent, relevant experience.

### Learner entry requirements

Centres must ensure that all learners have the opportunity to gain the qualification through appropriate study and training, and that any prerequisites stated in the *What is this qualification about?* section are met when registering on this qualification.

### Age restrictions

This qualification is approved for learners aged 16 – 19, 19+.

### 3 Delivering technical qualifications

#### 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 learning or training needs,
- support and guidance they may need when working towards their qualification,
- the appropriate type and level of qualification.

We recommend that centres provide an introduction so that learners fully understand 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.

#### Employer involvement

Employer involvement is essential to maximise the value of each learner's experience. Centres are required to involve employers in the delivery of technical qualifications at Key Stage 5 and/or their assessment, for every learner. This must be in place or planned before delivery programmes begin in order to gain qualification approval. See *Section 4: Employer involvement* for more detail.

#### Support materials

The following resources are available for this qualification:

Description	How to access
Sample assessments Guidance for delivery Guidance on use of marking grids	Available 2016 on the qualification pages on the City & Guilds Website: <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>

## 4 Employer involvement

Employer involvement is a formal component of Key Stage 5 Technical qualifications. It does not contribute to the overall qualification grading, but is a mandatory requirement that all learners must meet. As such it is subject to external quality assurance by City & Guilds.

Department for Education (DfE) requirements state:

*Employer involvement in the delivery and/or assessment of technical qualifications provides a clear 'line of sight' to work, enriches learning, raises the credibility of the qualification in the eyes of employers, parents and students and furthers collaboration between the learning and skills sector and industry.*

*[Technical qualifications] must:*

- *require all students to undertake meaningful activity involving employers during their study; and*
- *be governed by quality assurance procedures run by the awarding organisation to confirm that education providers have secured employer involvement for every student.*

Extract from: ***Vocational qualifications for 16 to 19 year olds, 2017 and 2018 performance tables: technical guidance for awarding organisations, paragraphs 89-90***

City & Guilds will provide support, guidance and quality assurance of employer involvement.

### Qualification approval

To be approved to offer City & Guilds technicals, centres must provide an Employer Involvement planner and tracker showing how every learner will be able to experience meaningful employer involvement, and from where sufficient and suitable employer representatives are expected to be sourced.

Centres must include in their planer a sufficient range of activities throughout the learning programme that provide a range of employer interactions for learners. Centres must also plan contingencies for learners who may be absent for employer involvement activities, so that they are not disadvantaged.

As part of the approval process, City & Guilds will review this planner and tracker. Centres which cannot show sufficient commitment from employers and/or a credible planner and tracker will be given an action for improvement with a realistic timescale for completion. **Approval will not be given** if employer involvement cannot be assured either at the start of the qualification, or through an appropriate plan of action to address this requirement before the learner is certificated.

### Monitoring and reporting learner engagement

Employer involvement is a formal component of this qualification and is subject to quality assurance monitoring. Centres must record evidence that demonstrates that each learner has been involved in meaningful employer based activities against the mandatory content before claiming the employer involvement component for learners.

Centres must record the range and type of employer involvement each learner has experienced and submit confirmation that all learners have met the requirements to City & Guilds. If a centre cannot provide evidence that learners have met the requirements to achieve the component, then the learner will not be able to achieve the overall Technical Qualification.

## Types of involvement

Centres should note that to be eligible, employer involvement activities **must** relate to one or more elements of the mandatory content of this qualification.

As the aim of employer involvement is to enrich learning and to give learners a taste of the expectations of employers in the industry area they are studying, centres are encouraged to work creatively with local employers.

Employers can identify the areas of skills and knowledge in their particular industry that they would wish to see emphasised for learners who may apply to work with them in the future. Centres and employers can then establish the type of input, and which employer representative might be able to best support these aims.

To be of most benefit this must add to, rather than replace the centre's programme of learning.

Some examples of meaningful employer involvement are listed below. Employer involvement not related to the mandatory element of the qualification, although valuable in other ways, does not count towards this element of the qualification.

The DfE has provided the following examples of what does and does not count as meaningful employer involvement, as follows<sup>1,2</sup>:

### ***The following activities meet the requirement for meaningful employer involvement:***

- *students undertake structured work-experience or work-placements that develop skills and knowledge relevant to the qualification<sup>3</sup>;*
- *students undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s);*
- *students take one or more units delivered or co-delivered by an industry practitioner(s). This could take the form of master classes or guest lectures;*
- *industry practitioners operate as 'expert witnesses' that contribute to the assessment of a student's work or practice, operating within a specified assessment framework. This may be a specific project(s), exercise(s) or examination(s), or all assessments for a qualification.*

*In all cases participating industry practitioners and employers must be relevant to the industry sector or occupation/occupational group to which the qualification relates.*

### ***The following activities, whilst valuable, do not meet the requirement for meaningful employer involvement:***

- *employers' or industry practitioners' input to the initial design and content of a qualification;*
- *employers hosting visits, providing premises, facilities or equipment;*
- *employers or industry practitioners providing talks or contributing to delivery on employability, general careers advice, CV writing, interview training etc;*
- *student attendance at career fairs, events or other networking opportunities;*
- *simulated or provider-based working environments eg hairdressing salons, florists, restaurants, travel agents, small manufacturing units, car servicing facilities;*
- *employers providing students with job references.*

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<sup>1</sup> As extracted from: Vocational qualifications for 16 to 19 year olds  
2017 and 2018 performance tables: technical guidance for awarding organisations

<sup>2</sup> This list has been informed by a call for examples of good practice in employer involvement in the delivery and assessment of technical qualifications - **Employer involvement in the delivery and assessment of vocational qualifications**

<sup>3</sup> DfE work experience guidance

## Types of evidence

For each employer involvement activity, centres are required to provide evidence of which learners undertook it, e.g. a candidate attendance register. The types of additional evidence required to support a claim for this component will vary depending on the nature of the involvement. E.g. for a guest lecture it is expected that a synopsis of the lecture and register would be taken which each learner and the guest speaker will have signed; expert witnesses will be identified and will have signed the relevant assessment paperwork for each learner they have been involved in assessing; evidence of contribution from employers to the development of locally set or adapted assignments.

## Quality assurance process

As the employer involvement component is a requirement for achieving the KS5 Technical qualifications, it is subject to external quality assurance by City & Guilds at the approval stage and when centres wish to claim certification for learners.

Evidence will be validated by City & Guilds before learners can achieve the employer involvement component. Where employer involvement is not judged to be sufficient, certificates cannot be claimed for learners.

## Sufficiency of involvement for each learner

It is expected that the centre will plan a range of activities that provide sufficient opportunities for each learner to interact directly with a range of individuals employed in the related industry. Centres must also provide contingencies for learners who may be absent for part of their teaching, so they are not disadvantaged. Any absence that results in a learner missing arranged activities must be documented. Where learners are unable to undertake all employer involvement activities due to temporary illness, temporary injury or other indisposition, centres should contact City & Guilds for further guidance.

## Live involvement

Learners will gain most benefit from direct interaction with employers and/or their staff; however the use of technology (e.g. the use of live webinars) is encouraged to maximise the range of interactions. Where learners are able to interact in real time with employers, including through the use of technology, this will be classed as 'live involvement'.

It is considered good practice to record learning activities, where possible, to allow learners to revisit their experience and to provide a contingency for absent learners. This is not classed as live involvement however, and any involvement of this type for a learner must be identified as contingency.

## Timing

A learner who has not met the minimum requirements cannot be awarded the component, and will therefore not achieve the qualification. It is therefore important that centres give consideration to scheduling employer involvement activities, and that enough time is allotted throughout delivery and assessment of the qualification to ensure that requirements are fully met.

## 5 Assessment

### Summary of assessment methods and conditions

Component numbers	Assessment method	Description and conditions
040/540, 046/546, 048/548 and 550	Externally marked exam	<p>The exam is <b>externally set and externally marked</b>, and will be taken either online (040, 046, 048) through City &amp; Guilds' computer-based testing platform or by paper (540, 546, 548, 550). The exam is designed to assess the candidate's depth and breadth of understanding across content in the qualification at the end of the period of learning, using a range of question types and will be sat under invigilated examination conditions. See JCO requirements for details: <a href="http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations">http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations</a></p> <p>The exam specification shows the coverage of the exam across the qualification content.</p> <p>Candidates who fail the exam at the first sitting will have a maximum of <b>two</b> opportunities to retake. If the candidate fails the exam three times then they will fail the qualification. (Note: the third and final retake opportunity applies to Level 3 only.)</p> <p>For exam dates, please refer to the Assessment and Examination timetable.</p>

041, 047, 049 and 051	Synoptic assignment	<p>The synoptic assignment is <b>externally set, internally marked and externally moderated</b>. The assignment requires candidates to identify and use effectively in an integrated way an appropriate selection of skills, techniques, concepts, theories, and knowledge from across the content area. Candidates will be judged against the assessment objectives.</p> <p>Assignments will be released to centres as per dates indicated in the Assessment and Examination timetable published on our website.</p> <p>Centres will be required to maintain the security of all live assessment materials. Assignments will be password protected and released to centres through a secure method.</p> <p>There will be one opportunity within each academic year to sit the assignment. Candidates who fail the assignment will have <b>one</b> re-sit opportunity. The re-sit opportunity will be in the next academic year, and will be the assignment set for that academic year once released to centres. If the re-sit is failed, the candidate will fail the qualification.</p> <p>Please note that for externally set assignments City &amp; Guilds provides guidance and support to centres on the marking and moderation process.</p>
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### What is synoptic assessment?

Technical qualifications are based around the development of a toolkit of knowledge, understanding and skills that an individual needs in order to have the capability to work in a particular industry or occupational area. Individuals in all technical areas are expected to be able to apply their knowledge, understanding and skills in decision making to solve problems and achieve given outcomes independently and confidently.

City & Guilds technical qualifications require candidates to draw together their learning from across the qualification to solve problems or achieve specific outcomes by explicitly assessing this through the synoptic assignment component.

In this externally set, internally marked and externally moderated assessment the focus is on bringing together, selecting and applying learning from across the qualification rather than demonstrating achievement against units or subsets of the qualification content. The candidate will be given an appropriately levelled, substantial, occupationally relevant problem to solve or outcome to achieve. For example this might be in the form of a briefing from a client, leaving the candidate with the scope to select and carry out the processes required to achieve the client's wishes, as they would in the workplace.

Candidates will be marked against assessment objectives (AOs) such as their breadth and accuracy of knowledge, understanding of concepts, and the quality of their technical skills as well as their ability to use what they have learned in an integrated way to achieve a considered and high quality outcome.

### **How the assignment is synoptic for this qualification**

The typical assignment brief could be to respond to a design problem for a new engineered product or adapting an existing product.

This will require the candidate to carry out experiments on a prototype to evaluate the suitability of different materials. Learners will produce a design specification, with drawings, for a design that meets the brief and produce a production plan for its manufacture. They will need to produce a report on developing the design into a commercial product.

### **External exam for stretch, challenge and integration**

The external assessment will draw from across the mandatory content of the qualification, using a range of shorter questions to confirm breadth of knowledge and understanding. Extended response questions are included to go into more depth, giving candidates the opportunity to demonstrate higher level understanding and integration through discussion, analysis and evaluation, and ensuring the assessment can differentiate between 'just able' and higher achieving candidates.



## Assessment objectives

The assessments for this qualification are set against a set of assessment objectives (AOs) which are used across all City & Guilds Technicals to promote consistency among qualifications of a similar purpose. They are designed to allow judgement of the candidate to be made across a number of different categories of performance.

Each assessment for the qualification has been allocated a set number of marks against these AOs based on weightings recommended by stakeholders of the qualification. This mark allocation remains the same for all versions of the assessments, ensuring consistency across assessment versions and over time.

The following table explains all AOs in detail, including weightings for the synoptic assignments. In some cases, due to the nature of a qualification's content, it is not appropriate to award marks for some AOs. Where this is the case these have been marked as N/A. Weightings for exams (AOs 1, 2 and 4 only) can be found with the exam specification.

Assessment objective	Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (720) Typical expected evidence of knowledge, understanding and skills	Approximate weighting (Assignment)
<b>AO1</b> Recalls knowledge from across the breadth of the qualification.	Identification of construction forms, methods, techniques, materials and their properties, document requirements, information required to complete building regulations applications, factors relating to human comfort and related design values, drafting techniques, legislation and regulations, roles and responsibilities, use of terminology, basic business management techniques as applied to construction, importance of sustainability, energy efficiency, renewable and alternative energy technologies.	20%
<b>AO2</b> Demonstrates understanding of concepts, theories and processes from across the breadth of the qualification.	Explanations/comparisons related to material and component specifications and performance, why and when different methods, techniques, materials are used, principles (eg design, risk management, electrical, building services provision), selection of measurement, estimating and tendering principles, basic methods used to value and manage property	35%
<b>AO3</b> Demonstrates technical skills from across the breadth of the qualification.	Working with documentation (project, planning, building regulations, support), producing tender figures, using surveying instruments, production of plans and drawings (2D, 3D), use of CAD, undertaking surveys (building, measured), carrying out a risk assessment, production planning and control	10%

Assessment objective	<b>Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (720)</b> Typical expected evidence of knowledge, understanding and skills	Approximate weighting (Assignment)
<b>AO4</b> Applies knowledge, understanding and skills from across the breadth of the qualification in an integrated and holistic way to achieve specified purposes.	Applying knowledge and understanding to a particular scenario/problem, justifying decisions/approaches taken (eg materials, techniques, appropriate attention to human comfort factors given stated requirements), adapting practice to meet contextual challenges (eg surveying difficult sites, finding cost reductions to win a tender), application of measurement, tendering and estimating techniques, integration of sustainable technology and energy efficiency	20%
<b>AO5</b> Demonstrates perseverance in achieving high standards and attention to detail while showing an understanding of wider impact of their actions.	Accuracy and detail of drawings, attention to accuracy during surveying, thinking about and attending to specific requirements of the client, completeness and attention to usability of documentation, attention to detail in risk assessment and risk reduction/method statements	15%

## Exam specifications

Assessment Objective weightings per exam.

Assessment Objective	040/540 weighting (approx. %)	Exam 2 weighting (approx. %)
AO1 Recalls knowledge from across the breadth of the qualification.	37	35
AO2 Demonstrates understanding of concepts, theories and processes from across the breadth of the qualification.	43	45
AO4 Applies knowledge, understanding and skills from across the breadth of the qualification in an integrated and holistic way to achieve specified purposes.	20	20

The way the exams cover the content of the qualification is laid out in the tables below:

**Assessment type:** Examiner marked, written exam\*

**Assessment conditions:** Invigilated examination conditions

**Grading:** X/P/M/D

Exam 040/540	Duration: 120 minutes		
Unit number	Unit title	Number of marks	%
301	Domestic construction technology	18	30
302	Industrial and commercial construction technology	18	30
303	Health and safety in the Built Environment	12	20
N/A	Integration across the units	12	20
Total		60	100

**Assessment type:** Examiner marked, written exam \*

**Assessment conditions:** Invigilated examination conditions

**Grading:** X/P/M/D

Exam 046/546	Duration: 120 minutes		
Unit number	Unit title	Number of marks	%
306	Measurement, tendering and estimating	18	30
313	Property maintenance and conversion	18	30
316	Building regulations	12	20
N/A	Integration across the units	12	20
Total		60	100

**Assessment type:** Examiner marked, written exam \*

**Assessment conditions:** Invigilated examination conditions

**Grading:** X/P/M/D

Exam 048/548	Duration: 120 minutes		
Unit number	Unit title	Number of marks	%
313	Property maintenance and conversion	18	30
314	Building surveying	18	30
316	Building regulations	12	20
N/A	Integration across the units	12	20
Total		60	100

**Assessment type:** Examiner marked, written exam, delivered by paper only \*

**Assessment conditions:** Invigilated examination conditions

**Grading:** X/P/M/D

Exam 550	Duration: 120 minutes		
Unit number	Unit title	Number of marks	%
307	Site surveying	12	20
308	Structural mechanics	18	30
309	Civil engineering technology	18	30
N/A	Integration across the units	12	20
Total		60	100

\*These exams are sat under invigilated examination conditions, as defined by the JCQ:  
<http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations>

Entry for exams can be made through the City & Guilds Walled Garden.

## 6 Moderation and standardisation of assessment

City & Guilds' externally set assignments for technical qualifications are designed to draw from across the qualifications' content, and to contribute a significant proportion towards the learner's final qualification grade. They are subject to a rigorous external quality assurance process known as external moderation. This process is outlined below. For more detailed information, please refer to 'Marking and moderation - Technicals centre guidance' available to download on the City & Guilds website.

It is vital that centres familiarise themselves with this process, and how it impacts on their delivery plan within the academic year.

### Supervision and authentication of internally assessed work

The Head of Centre is responsible for ensuring that internally assessed work is conducted in accordance with City & Guilds' requirements.

City & Guilds requires both tutors and candidates to sign declarations of authenticity. If the tutor is unable to sign the authentication statement for a particular candidate, then the candidate's work cannot be accepted for assessment.

### Internal standardisation

For internally marked work<sup>4</sup> the centre is required to conduct internal standardisation to ensure that all work at the centre has been marked to the same standard. It is the Internal Quality Assurer's (IQA's) responsibility to ensure that standardisation has taken place, and that the training includes the use of reference and archive materials such as work from previous years as appropriate.

### Provision for reworking evidence after submission for marking by the tutor

It is expected that in many cases a candidate who is struggling with a specific piece of work may themselves choose to restart and rectify the situation during their normal allocated time, and before it gets to the stage of it being handed in for final marking by the tutor.

In exceptional circumstances however, where a candidate has completed the assignment in the required timescales, and has handed it in for marking by the tutor but is judged to have significantly underperformed, may be allowed to rework or supplement their original evidence for remarking prior to submission for moderation. For this to be allowed, the centre must be confident that the candidate will be able to improve their performance without additional feedback from their tutor and within the required timescales ie the candidate has shown they can perform sufficiently better previously in formative assessments.

The reworked and/or supplemented original evidence must be remarked by the tutor in advance of the original moderation deadline and the moderator informed of any candidates who have been allowed to resubmit evidence.

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<sup>4</sup> For any internally assessed optional unit assignments, the same process must be followed where assessors must standardise their interpretation of the assessment and grading criteria.

The process must be managed through the IQA. The justification for allowing a resubmission should be recorded and made available on request. The use of this provision will be monitored by City & Guilds.

### Internal appeal

Centres must have an internal process in place for candidates to appeal the marking of internally marked components, ie the synoptic assignment and any optional unit assignments. This must take place before the submission of marks for moderation. The internal process must include candidates being informed of the marks (or grades) the centre has given for internally assessed components, as they will need these to make the decision about whether or not to appeal.

Centres cannot appeal the outcome of moderation for individual candidates, only the moderation process itself. A request for a review of the moderation process should be made to **appeals@cityandguilds.com**.

### Moderation

Moderation is the process where external markers are standardised to a national standard in order to review centre marking of internally marked assessments. These markers are referred to as 'moderators'. Moderators will mark a representative sample of candidates' work from every centre. Their marks act as a benchmark to inform City & Guilds whether centre marking is in line with City & Guilds' standard.

Where moderation shows that the centre is applying the marking criteria correctly, centre marks for the whole cohort will be accepted.

Where moderation shows that the centre is either consistently too lenient or consistently too harsh in comparison to the national standard, an appropriate adjustment will be made to the marks of the whole cohort, retaining the centre's rank ordering.

Where centre application of the marking criteria is inconsistent, an appropriate adjustment for the whole cohort may not be possible on the basis of the sample of candidate work. In these instances a complete remark of the candidate work may be necessary. This may be carried out by the centre based on feedback provided by the moderator, or carried out by the moderator directly.

Moderation applies to all internally marked assignments. Following standardisation and marking, the centre submits all marks and candidate work to City & Guilds via the moderation platform. The deadline for submission of evidence will be available on Walled Garden. See the *Marking and moderation - Technicals Centre Guidance* document for full details of the requirements and process.

In most cases candidate work will be submitted directly to the moderator for moderation. This includes written work, photographic and pictorial evidence, or video and audio evidence. For some qualifications there will be a requirement for moderators to visit centres to observe practical assessments being undertaken. This will be for qualifications where the assessment of essential learner skills can only be demonstrated through live observation. The purpose of these visits is to ensure that the centre is assessing the practical skills to the required standards, and to provide the moderators with additional evidence to be used during moderation. These visits will be planned in advance with the centre for all relevant qualifications.

### **Post-moderation procedures**

Once the moderation process has been completed, the confirmed marks for the cohort are provided to the centre along with feedback from the moderator on the standard of marking at the centre, highlighting areas of good practice, and potential areas for improvement. This will inform future marking and internal standardisation activities.

City & Guilds will then carry out awarding, the process by which grade boundaries are set with reference to the candidate evidence available on the platform.

### **Centres retaining evidence**

Centres must retain assessment records for each candidate for a minimum of three years. To help prevent plagiarism or unfair advantage in future versions, candidate work may not be returned to candidates. Samples may however be retained by the centre as examples for future standardisation of marking.



## 7 Grading

### Awarding individual assessments

Individual assessments will be graded, by City & Guilds, as pass/merit/distinction where relevant. The grade boundaries for pass and distinction for each assessment will be set through a process of professional judgement by technical experts. Merit will usually be set at the midpoint between pass and distinction. The grade descriptors for pass and distinction, and other relevant information (eg archived samples of candidate work and statistical evidence) will be used to determine the mark at which candidate performance in the assessment best aligns with the grade descriptor in the context of the qualification's purpose. Boundaries will be set for each version of each assessment to take into account relative difficulty.

Please note that as the merit grade will usually be set at the arithmetical midpoint between pass and distinction, there are no descriptors for the merit grade for the qualification overall.

### Grade descriptors

#### To achieve a pass, a candidate will be able to

- Demonstrate the knowledge and understanding required to work in the occupational area, its principles, practices and legislation.
- Describe some of the main factors impacting on the occupation to show good understanding of how work tasks are shaped by the broader social, environmental and business environment it operates within.
- Use the technical industry specific terminology used in the industry accurately.
- Demonstrate the application of relevant theory and understanding to solve non-routine problems.
- Interpret a brief for complex work related tasks, identifying the key aspects, and showing a secure understanding of the application of concepts to specific work related tasks.
- Carry out planning which shows an ability to identify and analyse the relevant information in the brief and use knowledge and understanding from across the qualification (including complex technical information) to interpret what a fit for purpose outcome would be and develop a plausible plan to achieve it.
- Achieve an outcome which successfully meets the key requirements of the brief.
- Identify and reflect on the most obvious measures of success for the task and evaluate how successful they have been in meeting the intentions of the plan.
- Work safely throughout, independently carrying out tasks and procedures, and having some confidence in attempting the more complex tasks.

#### To achieve a distinction, a candidate will be able to

- Demonstrate the excellent knowledge and understanding required to work to a high level in the occupational area, its principles, practices and legislation.
- Analyse the impact of different factors on the occupation to show deep understanding of how work tasks are shaped by the broader social, environmental, and business environment it operates within.
- Demonstrate the application of relevant theory and understanding to provide efficient and effective solutions to complex and non-routine problems.
- Analyse the brief in detail, showing confident understanding of concepts and themes from across the qualification content, bringing these together to develop a clear and stretching plan, that would credibly achieve an outcome that is highly fit for purpose.

- Achieve an outcome which shows an attention to detail in its planning, development and completion, so that it completely meets or exceeds the expectations of the brief to a high standard.
- Carry out an evaluation in a systematic way, focussing on relevant quality points, identifying areas of development/ improvement as well as assessing the fitness for purpose of the outcome.

### Awarding grades and reporting results

The overall qualification grade will be calculated based on aggregation of the candidate's achievement in each of the assessments for the mandatory units, taking into account the assessments' weighting. The qualification will be reported on a seven grade scale: Pass Pass, Pass Merit, Merit Merit, Merit Distinction, Distinction Distinction, Distinction Distinction\*, Distinction\* Distinction\*.

All assessments **must** be achieved at a minimum of pass for the qualification to be awarded. Candidates who fail to reach the minimum standard for grade pass for an assessment(s) will not have a qualification grade awarded and will not receive a qualification certificate.

Synoptic Assignment	Pass Mark (%)
041	42
047	42
049	42
051	42

The contribution of assessments towards the overall qualification grade for the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Construction) (720)** is as follows:

Assessment method	Grade scale	% contribution
Theory exam (040/540)	X/P/M/D	20%
Theory exam (046/546)	X/P/M/D	20%
Synoptic assignment (041)	X/P/M/D	30%
Synoptic assignment (047)	X/P/M/D	30%

Both synoptic assignments and exams are awarded (see 'Awarding individual assessments', at the start of Section 7, above), and candidates' grades converted to points. The minimum points available for each assessment grade is listed in the table below. The range of points between the pass, merit and distinction boundaries will be accessible to candidates. For example; a candidate that achieves a middle to high pass in an assessment will receive between 8 and 10 points, a candidate that achieves a low to middle merit in an assessment will receive between 12 and 14 points. The points above the minimum for the grade for each assessment are calculated based on the candidate's score in that assessment.

	Pass	Merit	Distinction
Theory exam (040/540): 20%	6	12	18
Theory exam (046/546): 20%	6	12	18
Synoptic assignment (041): 30%	6	12	18
Synoptic assignment (047): 30%	6	12	18

The weighted average of candidate's points for each assessment is calculated, and the overall grade of the qualification will then be determined using the following criteria.

Qualification Grade	Minimum points
Distinction*, Distinction*	20.5
Distinction, Distinction*	18.7
Distinction, Distinction	17
Merit, Distinction	14
Merit, Merit	11
Pass, Merit	8.5
Pass, Pass	6

Candidates achieving Distinction\*, Distinction \* will be the highest achieving of the Distinction candidates.

The contribution of assessments towards the overall qualification grade for the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Design and Planning) (720)** is as follows:

Assessment method	Grade scale	% contribution
Theory exam (040/540)	X/P/M/D	20%
Theory exam (048/548)	X/P/M/D	20%
Synoptic assignment (041)	X/P/M/D	30%
Synoptic assignment (049)	X/P/M/D	30%

Both synoptic assignments and exams are awarded (see 'Awarding individual assessments', at the start of Section 7, above), and candidates' grades converted to points. The minimum points available for each assessment grade is listed in the table below. The range of points between the pass, merit and distinction boundaries will be accessible to candidates. For example; a candidate that achieves a middle to high pass in an assessment will receive between 8 and 10 points, a candidate that achieves a low to middle merit in an assessment will receive between 12 and 14 points. The points above the minimum for the grade for each assessment are calculated based on the candidate's score in that assessment.

	Pass	Merit	Distinction
Theory exam (040/540): 20%	6	12	18
Theory exam (048/548): 20%	6	12	18
Synoptic assignment (041): 30%	6	12	18
Synoptic assignment (049): 30%	6	12	18

The weighted average of candidate's points for each assessment is calculated, and the overall grade of the qualification will then be determined using the following criteria.

Qualification Grade	Minimum points
Distinction*, Distinction*	20.5
Distinction, Distinction*	18.7
Distinction, Distinction	17
Merit, Distinction	14
Merit, Merit	11
Pass, Merit	8.5
Pass, Pass	6

Candidates achieving Distinction\*, Distinction \* will be the highest achieving of the Distinction candidates.

The contribution of assessments towards the overall qualification grade for the **Level 3 Advanced Technical Extended Diploma in Constructing the Built Environment (Civil Engineering) (720)** is as follows:

Assessment method	Grade scale	% contribution
Theory exam (040/540)	X/P/M/D	20%
Theory exam (550)	X/P/M/D	20%
Synoptic assignment (041)	X/P/M/D	30%
Synoptic assignment (051)	X/P/M/D	30%

Both synoptic assignments and exams are awarded (see 'Awarding individual assessments', at the start of Section 7, above), and candidates' grades converted to points. The minimum points available for each assessment grade is listed in the table below. The range of points between the pass, merit and distinction boundaries will be accessible to candidates. For example; a candidate that achieves a middle to high pass in an assessment will receive between 8 and 10 points, a candidate that achieves a low to middle merit in an assessment will receive between 12 and 14 points. The points above the minimum for the grade for each assessment are calculated based on the candidate's score in that assessment.

	Pass	Merit	Distinction
Theory exam (040/540): 20%	6	12	18
Theory exam (550): 20%	6	12	18
Synoptic assignment (041): 30%	6	12	18
Synoptic assignment (051): 30%	6	12	18

The weighted average of candidate's points for each assessment is calculated, and the overall grade of the qualification will then be determined using the following criteria.

Qualification Grade	Minimum points
Distinction*, Distinction*	20.5
Distinction, Distinction*	18.7
Distinction, Distinction	17
Merit, Distinction	14
Merit, Merit	11
Pass, Merit	8.5
Pass, Pass	6

Candidates achieving Distinction\*, Distinction \* will be the highest achieving of the Distinction candidates.

## 8 Administration

Approved centres must have effective quality assurance systems to ensure valid and reliable delivery and assessment of qualifications. Quality assurance includes initial centre registration by City & Guilds and the centre's own internal procedures for monitoring quality assurance procedures.

Consistent quality assurance requires City & Guilds and its associated centres to work together closely; our Quality Assurance Model encompasses both internal quality assurance (activities and processes undertaken within centres) and external quality assurance (activities and processes undertaken by City & Guilds).

For this qualification, standards and rigorous quality assurance are maintained by the use of:

- internal quality assurance
- City & Guilds external moderation.

In order to carry out the quality assurance role, Internal Quality Assurers (IQAs) must have and maintain an appropriate level of technical competence and have recent relevant assessment experience. For more information on the requirements, refer to *Section 2: Centre requirements* in this handbook.

To meet the quality assurance criteria for this qualification, the centre must ensure that the following procedures are followed:

- suitable training of staff involved in the assessment of the qualification to ensure they understand the process of marking and standardisation
- completion by the person responsible for internal standardisation of the Centre Declaration Sheet to confirm that internal standardisation has taken place
- the completion by candidates and supervisors/tutors of the record form for each candidate's work.

### External quality assurance

City & Guilds will undertake external moderation activities to ensure that the quality assurance criteria for this qualification are being met. Centres must ensure that they co-operate with City & Guilds staff and representatives when undertaking these activities.

City & Guilds requires the Head of Centre to

- facilitate any inspection of the centre which is undertaken on behalf of City & Guilds
- make arrangements to receive, check and keep assessment material secure at all times,
- maintain the security of City & Guilds confidential material from receipt to the time when it is no longer confidential and
- keep completed assignment work and examination scripts secure from the time they are collected from the candidates to their dispatch to City & Guilds.

### Enquiries about results

The services available for enquiries about results include a review of marking for exam results and review of moderation for internally marked assessments.

For further details on enquiries and appeals process and for copies of the application forms, please visit the **appeals page** of the City & Guilds website at **[www.cityandguilds.com](http://www.cityandguilds.com)**.

### Re-sits and shelf-life of assessment results

Candidates who have failed an exam or wish to re-take it in an attempt to improve their grade, can do so **twice**. The best result will count towards the final qualification. See guidance on individual assessment types in Section 5.

### Factors affecting individual learners

If work is lost, City & Guilds should be notified immediately of the date of the loss, how it occurred, and who was responsible for the loss. Centres should use the JCQ form, JCQ/LCW, to inform City & Guilds Customer Services of the circumstances.

Learners who move from one centre to another during the course may require individual attention. Possible courses of action depend on the stage at which the move takes place. Centres should contact City & Guilds at the earliest possible stage for advice about appropriate arrangements in individual cases.

### Malpractice

Please refer to the City & Guilds guidance notes *Managing cases of suspected malpractice in examinations and assessments*. This document sets out the procedures to be followed in identifying and reporting malpractice by candidates and/or centre staff and the actions which City & Guilds may subsequently take. The document includes examples of candidate and centre malpractice and explains the responsibilities of centre staff to report actual or suspected malpractice. Centres can access this document on the City & Guilds website.

Examples of candidate malpractice are detailed below (please note that this is not an exhaustive list):

- falsification of assessment evidence or results documentation
- plagiarism of any nature
- collusion with others
- copying from another candidate (including the use of ICT to aid copying), or allowing work to be copied
- deliberate destruction of another's work
- false declaration of authenticity in relation to assessments
- impersonation.

These actions constitute malpractice, for which a penalty (eg disqualification from the assessment) will be applied.

Where suspected malpractice is identified by a centre after the candidate has signed the declaration of authentication, the Head of Centre must submit full details of the case to City & Guilds at the earliest opportunity. Please refer to the form in the document *Managing cases of suspected malpractice in examinations and assessments*.

### Access arrangements and special consideration

Access arrangements are adjustments that allow candidates with disabilities, special educational needs and temporary injuries to access the assessment and demonstrate their skills and knowledge without changing the demands of the assessment. These arrangements must be made before assessment takes place.



It is the responsibility of the centre to ensure at the start of a programme of learning that candidates will be able to access the requirements of the qualification.

Please refer to the *JCQ access arrangements and reasonable adjustments* and *Access arrangements - when and how applications need to be made to City & Guilds* for more information. Both are available on the City & Guilds website: <http://www.cityandguilds.com/delivering-our-qualifications/centre-development/centre-document-library/policies-and-procedures/access-arrangements-reasonable-adjustments>

### **Special consideration**

We can give special consideration to candidates who have had a temporary illness, injury or indisposition at the time of the examination. Where we do this, it is given after the examination.

Applications for either access arrangements or special consideration should be submitted to City & Guilds by the Examinations Officer at the centre. For more information please consult the current version of the JCQ document, *A guide to the special consideration process*. This document is available on the City & Guilds website: <http://www.cityandguilds.com/delivering-our-qualifications/centre-development/centre-document-library/policies-and-procedures/access-arrangements-reasonable-adjustments>

<b>UAN:</b>	J/506/5399
<b>Level:</b>	3
<b>GLH:</b>	60

### **What is this unit about?**

The purpose of this unit is for learners to develop an understanding of the technology used in the construction of low-rise domestic buildings. Learners will explore the processes, techniques and technologies used to create such buildings, and will investigate construction projects in terms of the important stages, using detailed construction drawings, specifications and schedules of work.

The unit compares modern methods of construction with traditional methods and investigates the advantages of modern methods of construction such as lower costs, shorter project durations, enhanced health and safety and reduced environmental concerns.

The unit also explores the environmental impact of low-rise domestic buildings and the methods used to monitor and control that impact.

### **Learning outcomes**

In this unit, learners will be able to

1. identify the different forms, elements, components and materials used in domestic construction
2. recognise traditional and modern methods of domestic construction
3. understand how domestic buildings perform in use.

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved. Learners do not need any prior knowledge of domestic construction technology in order to understand this unit, but it is anticipated that learners will possess basic literacy and numeracy skills.

### Learning outcome:

1. Identify the different forms, elements, components and materials used in domestic construction

### Topics

- 1.1 Substructure and superstructure forms
- 1.2 Primary and secondary elements
- 1.3 Components and materials

#### Topic 1.1

##### Substructure

Learners must understand and use appropriate technical terminology to describe domestic buildings. They must be able to determine which materials are to be used for substructure development. They must also understand why such materials are used in specific places, both for their properties and the quality of their finish. Learners must understand that substructure work is work carried out below damp-proof course level. This includes the structure on which the building stands, including foundations such as:

- strip
- raft
- pile
- pad and beam

There is no requirement for the learners to understand how building services are distributed inside low-rise domestic buildings at this stage. However, learners must understand how the following building services are incorporated into the substructure:

- electricity
- gas
- cold water
- drainage
- telecoms

Learners will also need to understand the construction of basements including:

- methods of construction
- excavations, external and internal support systems
- tanking

##### Superstructure

Learners must understand and use appropriate technical terminology to describe domestic buildings. They must be able to determine the materials used for superstructures. They must be aware of why materials are used in specific places, both for their properties and the quality of their finish. Learners must understand that superstructure is that part of the building above the damp-proof course.

- Traditional on-site methods (brick and block, concrete, stone)

- Modern pre-fabricated methods (timber frame, steel frame, cladding, trussed rafters, pods)

### Topic 1.2

Learners must be able to differentiate between primary and secondary elements of buildings and explain the function of each.

- Primary elements (walls, floors, roofs)
- Secondary elements (doors, windows, partitions, staircases, fixtures and fittings)

### Topic 1.3

Learners must be able to describe how components and materials are incorporated into buildings

- Components (cladding, roof systems, internal partitions, raised floors, suspended ceilings)
- Materials (concrete, metals, timber, masonry, plastic, glass)

## Learning outcome:

### 2. Recognise traditional and modern methods of domestic construction

#### Topics

2.1 Methods used in traditional and modern construction

2.2 Characteristics of traditional and modern methods of construction

#### Topic 2.1

Learners must build upon Topic 1.2 to develop an understanding of the traditional methods used to construct low-rise domestic buildings using the following materials:

- brick and block
- stone
- timber

Learners must build upon Topic 1.2 to develop an understanding of the modern methods used to construct low-rise domestic buildings using the following techniques:

- timber frame
- panelised
- mass concrete
- thin joint
- volumetric (pod/modular)

#### Topic 2.2

Learners must understand the characteristics of traditional and modern methods of construction and be able to specify the advantages and disadvantages of each method.

- Traditional methods (all work done on-site, labour intensive, longer build times, more waste generated, low levels of mechanisation, weather dependent)
- Modern methods (off-site prefabrication, modularisation, greater use of construction plant, better quality control, shorter build times, reduced labour requirement)

## Learning outcome:

### 3. Understand how domestic buildings perform in use

## Topics

3.1 Performance expectations

3.2 Environmental issues

### Topic 3.1

Learners must understand what low-rise domestic buildings are required to do in order to achieve their design function. They must be able to link the following functions of domestic buildings to the form of construction chosen, and the methods used in their construction:

- weather exclusion
- durability
- structural performance
- fire resistance
- thermal performance
- sound insulation
- security
- access and egress

### Topic 3.2

Learners must understand that even low-rise domestic buildings can have an environmental impact, both during construction and in use, and must understand how each of the following are used to monitor and control that environmental impact.

- Environmental Impact Assessment (EIA)
- Energy Performance Certificates (EPC)
- Code for Sustainable Homes
- Waste management plans
- Building Regulations (Part L)

## Guidance for delivery

Staff delivering this unit will have an opportunity to use a wide range of techniques, lectures, guest speakers, industry experts, discussions, case studies, DVDs and video footage. Tutors are advised to use seminar presentations, site visits, supervised practical activities, research using internet and/or library resources and the use of personal and/or industrial experiences as appropriate. Site visits are the most important of the many learning tools and learners should be provided with the opportunity to visit as many housing sites as possible, preferably at different stages of construction, in order to see the process in real life, as it happens.

Visiting guest speakers could also add to the relevance of the subject to bring the learning to life. This can be combined with site visits where time is short, and where it is more convenient for those providing the learners with the benefit of their on-site experience.

An understanding and demonstration of health and safety must be integrated at all times into the lessons. Centres would benefit from links with local construction companies or the building department of a local authority who will carry out a selection of work that can be related and applied to lessons. Staff should apply learning within real-life working environments, as this is vital for learner engagement, motivation and development.

## Unit 302

## Industrial and commercial construction technology

<b>UAN:</b>	M/506/5400
<b>Level:</b>	3
<b>GLH:</b>	60

### What is this unit about?

The purpose of this unit is to develop the learners' knowledge and understanding of industrial and commercial construction technology.

Learners will investigate the technology and construction techniques used to construct industrial and commercial buildings and will study alternative types of structure and the materials and processes used. Learners will also be given the opportunity to investigate the use of alternative technologies and materials for sustainable buildings.

The unit compares the alternative forms of construction used for industrial and commercial buildings including, where appropriate, the inclusion of modern methods of construction and the need to ensure buildings are energy-efficient in both construction and use. Learners should be able to describe construction techniques and compare different types of structure, building fabrics, techniques, application methods and appropriate terminology, to produce solutions for a range of building designs and client requirements.

The learner will be given the opportunity to identify and describe the most suitable construction to bring a construction project to a successful conclusion in terms of groundwork, substructure and superstructure.

### Learning outcomes

In this unit, learners will be able to

1. recognise the methods used in industrial and commercial construction
2. understand site preparation and substructure work in industrial and commercial construction
3. understand superstructure work in industrial and commercial construction
4. identify roofing work in industrial and commercial construction

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Recognise the methods used in industrial and commercial construction

### Topics

- 1.1 Types of industrial and commercial buildings Primary and secondary elements
- 1.2 Common construction forms
- 1.3 Materials used to construct common forms

#### Topic 1.1

Learners must understand and use appropriate technical terminology to describe the following industrial and commercial buildings.

- Factories
- Stores
- Petrol stations
- Hotels
- Supermarkets
- Warehouses
- Garages
- Breweries
- Foundries
- Power stations

#### Topic 1.2

Learners must be able to determine the most appropriate form of structure for a given project. They must be aware of the uses and limitations of the various construction techniques available to them and understand the function of a building and how this influences the specification of the building.

- Concrete and steel framed buildings
- Timber, concrete and steel portal frames
- Cross wall
- Fin wall
- Diaphragm walling
- Panelised

#### Topic 1.3

Learners must understand the materials used to construct common forms of industrial and commercial buildings and the reasons for their specification.

- Precast concrete
- Cast in situ concrete
- Pre-stressing and post-tensioning techniques
- Steel
- Laminated timber
- Brick and block

### Learning outcome:

## 2. Understand site preparation and substructure work in industrial and commercial construction

### Topics

- 2.1 Site and soil investigations
- 2.2 Site preparation techniques
- 2.3 Types and uses of foundations

Learners must understand that before construction work commences it is necessary to collect information on previous and current uses of the site. This is done to ensure that correct decisions are made when planning the site layout. Learners must be able to explain the various methods of soil investigation and be able to interpret borehole logs.

Using the information from site investigation and borehole logs learners must be able to choose and sketch the most appropriate form of foundation for a given situation.

#### Topic 2.1

Learners must understand that the objective of site investigation is to collect and record the information needed to help with the design and construction processes including:

- site boundaries
- access to site
- local roads
- trees, hedges and fences
- topography
- existing structures
- position of existing services
- wildlife and habitat.

Learners must understand the factors to be ascertained by soil investigations including:

- shear strength
- compressive strength
- plasticity
- permeability
- density (bulk and solid)
- porosity
- liquid limit
- moisture content
- position of water table
- chemical composition

Learners must understand the methods used to obtain both disturbed and undisturbed soil samples including:

- trial pits
- hand and mechanical augers
- bore hole logs
- interpretation of results of above.

#### Topic 2.2



Learners must understand the various forms of work that must be undertaken before construction can commence, including:

- dewatering – temporary and permanent
- contamination and remediation
- ground improvement techniques (consolidation, compaction).

### **Topic 2.3**

Learners must be able to specify the most appropriate foundation types for industrial and commercial buildings in given situations and given soil conditions.

They should be able to sketch foundation details for:

- deep strip, wide strip, trench fill
- reinforced raft
- piles
- pad.

## **Learning outcome:**

### **3. Understand superstructure work in industrial and commercial construction**

#### **Topics**

- 3.1 Forming connections to construction elements
- 3.2 Wall construction
- 3.3 Floor construction

#### **Topic 3.1**

Learners must be able to explain the various methods of forming beam and column connections in steel and concrete. Learners must also be able to identify and sketch portal frame design using rigid two-pin or three-pin frames.

- Precast and cast in situ concrete frame connections
- Steel frame connections
- Timber, concrete and steel portal frame connections

#### **Topic 3.2**

Learners must identify and sketch alternative forms of wall construction and recommend the most appropriate construction to be used in given situations. Consideration should also be given to thermal and sound insulation of the walls.

- Rainscreen cladding
- Panel and curtain walls
- Infill panels
- Metal profile sheeting

#### **Topic 3.3**

Learners must identify and sketch alternative forms of floor construction and recommend the most appropriate construction to be used in given situations. Consideration should also be given to thermal and sound insulation of the roofs.

- Floor construction techniques
- Precast concrete
  - Cast in-situ concrete
  - Pot and beam
  - Beam and block
- Provision for openings in floors

- Floor finishes

### Learning outcome:

#### 4. Identify roofing work in industrial and commercial construction

### Topics

- 4.1 Roof construction techniques
- 4.2 Roof coverings

#### Topic 4.1

Learners must be able to select and justify appropriate roof construction techniques for use with industrial and commercial building, and be able to sketch construction details and recommend appropriate types of roof covering. They must ensure that they have taken into account the need to provide roof structures that contribute to energy conservation in buildings. Learners must consider requirements of roof structures including the need to provide natural light using patent glazing, roof lights, lantern lights and light tunnels and the space requirements for plant rooms for lifts, heat pumps, air-conditioning and water tanks.

The following roofs should be investigated:

- pitched roof trusses
- northlight roofs
- monitor roofs
- flat roofs
- shell roofs
- space decks/frames.

#### Topic 4.2

The following forms of roof covering must be considered:

- metal roof covering
- plastic
- glass
- built-up felt
- asphalt
- EPDM (membrane)
- Glass Reinforced Plastic (GRP)
- green roofs
- slates and tiles.

### Guidance for delivery

Staff delivering this unit will have an opportunity to use a wide range of techniques, lectures, guest speakers/industry experts, discussions, case studies, use of DVD and video footage.

Centres should cover a wide range of technical detail relating to Industrial and commercial buildings encouraging learners to investigate alternative solutions to construction problems. Real-life industry visits to encourage debate, discussion and allow learners to appreciate the way in which buildings are required to perform in use would be very useful.

Staff are advised to use seminar presentations, site visits, supervised practical activities, research using internet and/or library resources and the use of personal and or industrial experiences are suitable.

Delivery of this unit should stimulate, motivate, educate and enthuse the learner. Visiting guest speakers could also add to the relevance of the subject to bring the learning to life.

An understanding and demonstration of the alternative uses for industrial and commercial buildings should be included.

Centres would benefit from links with local construction companies and local industry or commercial partners, many colleges, particularly those delivering construction and engineering disciplines, will have examples of various forms of construction suitable for study. Learners would benefit from educational visits to industrial and commercial premises including, leisure centres, schools, shopping centres and industrial premises to experience the range of structures and uses of the buildings. Staff should apply learning with real-life working environments and workshops, as this is vital for learner engagement, motivation and development.

Visits to construction sites will help to motivate learners and illustrate to them the importance and complexity of the construction industry.

UAN:	T/506/5401
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is for learners to develop knowledge and understanding of health and safety in the built environment.

The construction industry remains one of the largest in Great Britain, bringing employment to over two million people. It remains extremely hazardous, and therefore a cause for significant concern. The health and safety challenge for the industry is huge, and construction companies regularly hit the headlines for all the wrong reasons. The accident rate for construction industry workers is a cause for concern and companies must look to continually improve the health, safety and welfare of employees, sub-contractors, visitors and the general public, as far as is reasonably practicable.

Accidents remain at an unacceptable level despite all the legislation, regulations and preventative measures that have been introduced. The industry must continue to reduce the accident rate together with the associated injuries and incidences of ill-health.

In this unit learners must investigate the procedures associated with hazard identification and risk management. This must involve determining potential hazards in and around the workplace, considering who is at risk and deciding what control measures should be used.

Learners must also familiarise themselves with health and safety law, and what the legal responsibilities are for the various parties to the construction process.

### Learning outcomes

In this unit, learners will be able to

1. determine how and where accidents occur in the construction industry
2. apply the principles of risk management
3. understand health and safety legislation relevant to the construction industry
4. develop training materials for use in the construction industry

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

In order to fully understand this unit, learners need not have any prior knowledge of health and safety. It is however anticipated that learners hold GCSE Grades at Grade C or above in Mathematics and English Language and have the necessary literacy and numeracy skills to analyse data and complete the report aspects of the unit.

### Learning outcome:

#### 1. Determine how and where accidents occur in the construction industry

### Topics

- 1.1 Accident statistics
- 1.2 Causes of accidents
- 1.3 Recording and reporting accidents

#### Topic 1.1

Learners must be able to explain what the typical causes of accidents are and they must be able to identify potential hazards in and around the workplace. Definition of accident

- Hazard identification
- HSE data
- Current trends
- Company statistics (fatalities, near misses, major accidents, minor injuries)

#### Topic 1.2

There are many causes of accidents and these should be considered in cognate groups such as:

- slips, trips and falls
- hazardous materials
- use of electricity
- falling objects
- negligence and/or tiredness
- weather conditions
- hygiene and site housekeeping
- manual handling
- working in confined spaces
- on-site traffic

#### Topic 1.3

Learners must be able to explain the procedures for reporting accidents, incidents and dangerous occurrences. The following should be considered:

- accident procedures
  - employee duties (recording and reporting)
  - HSE notification
  - prevention of re-occurrence by ensuring safe working practices
- RIDDOR

### Learning outcome:

## 2. Apply the principles of risk management

### Topics

#### 2.1 Hazard analysis

#### 2.2 Risk management techniques

##### Topic 2.1

Learners must be able to identify the persons who could be harmed in the workplace and the steps to be taken to reduce or eliminate the risks of accidents. The following must be considered:

- people at risk
- common hazards
- site conditions
- asbestosis
- faulty tools and equipment
- poor site welfare
- poor hygiene
- weather conditions
- access and egress
- working at height or below ground
- confined spaces

##### Topic 2.2

Learners must also be able to apply appropriate techniques to prepare risk assessments for given scenarios. The following must be considered:

- risk assessments – 5 steps
- method statements
- human and workplace factors
- company policies and procedures

### Learning outcome:

## 3. Understand health and safety legislation relevant to the construction industry

### Topics

#### 3.1 Legislation and regulations

#### 3.2 Practical implementation of regulations

##### Topic 3.1

Learners will need to have knowledge of the different pieces of legislation that are used within the construction industry and why they are in place. Learners need to have an overview of the different legislation that is used to govern and protect workers and public whilst carrying out a range of construction duties and differentiate between the various forms of regulations. Most importantly, learners must have a basic understanding of the Health and Safety at Work Act 1974, and any regulations made under the Act. Other considerations must include reference to:

- Construction Design and Management Regulations 2007
- Control of Substances Hazardous to Health Regulations 2002
- Lifting Operations and Lifting Equipment regulations 1998
- Work at Height Regulations 2005

- Confined Spaces Regulations 1997
- Provision and Use of Work Equipment Regulations 1998
- Management of Health and Safety at Work Regulations 1999
- Personal Protective Equipment Regulations 1992
- Noise at Work Regulations 2005
- Reporting of Injuries Diseases and Dangerous Occurrences Regulations 2013.

### Topic 3.2

Learners must understand the corporate and human consequences of failing to comply with the practical implementation of health and safety legislation. Examples include:

- investigation
- improvement notice
- prohibition notice
- fines
- imprisonment
- confiscation of equipment
- seizure of assets
- death or injury
- emotional impact
- reputational damage
- contractual implications
- stoppage of work
- loss of income.

## Learning outcome:

### 4. Develop training materials for use in the construction industry

#### Topics

- 4.1 Training needs
- 4.2 Development of training material

#### Topic 4.1

Learners must have an understanding of the methods used on construction sites to make people aware of the dangers inherent in the industry. This can be achieved in a variety of ways including rigorous site inductions, mandatory training and regular toolbox talks. Learners must be able to contribute to the preparation and delivery of a range of toolbox talks. Factors to consider include:

- roles and responsibilities of everyone involved in and around a construction site
- industry-awarded qualifications
- competence schemes (e.g. CSCS cards, Green cards)
- permits to work
- induction checklists

#### Topic 4.2

Learners must be able to contribute to the preparation and delivery of a range of development materials. These could include:

- toolbox talks (for a range of work)
  - manual handling/safe lifting procedures

- use of mechanical lifting aids
  - asbestos
  - COSHH (Chemicals and combustibles)
  - working at height and hazards associated
  - plant and machinery hazards
  - drug and alcohol abuse in the workplace
  - risks in the workplace such as hand arm vibration, noise, respiratory illness, dermatitis, muscular skeletal problems, falling from height, struck by moving plant machinery
- signage
- enforcement of PPE (safety boots, hard hat, high visibility jacket, hand-protection, goggles, other PPE as appropriate)
- use PPE to minimise risks from dangers

## Guidance for delivery

Staff delivering this unit will have an opportunity to use a wide range of techniques, lectures, guest speakers/industry experts, discussions, case studies, use of DVD and video footage.

Centres should cover a wide range of health and safety activities to show and demonstrate potential hazards in and around the workplace. Real life industry visits to encourage debate, discussion, and to allow learners to experience the environment and what the potential dangers are.

The staff are advised to use seminar presentations, site visits, supervised practical activities, research using internet and/or library resources and the use of personal and or industrial experience. Delivery of this unit should stimulate, motivate, educate and enthuse the learner. Visiting guest speakers could also add to the relevance of the subject, bringing the learning to life.

An understanding and demonstration of health and safety must be integrated at all times into the lessons for all units. Centres would benefit from links with local construction companies, or the building department of a local authority, who will carry out a selection of work that can be related and applied to lessons.

Health and safety is always of paramount importance. Visits to college workshops, training providers and construction sites will help to motivate learners and illustrate to them the importance and complexity of the construction industry.

There is a comprehensive range of legislation that underpins health, safety and welfare in the construction industry and this must be obeyed at all times on-site and during delivery.



UAN:	A/506/5402
Level:	3
GLH:	60

### What is this unit about?

Construction supervisors, line managers, general forepersons, and those with potential for promotion to a supervisory level, are all essential members of the construction team.

A construction supervisor must have the essential knowledge and skills needed to carry out their responsibilities efficiently and effectively. They must have the confidence to use supervisory or management skills and knowledge in their work. This could range from the erection of new dwellings and structures to building maintenance, and the repair and upkeep of houses, offices, shops and other structures.

Construction supervisors oversee work activities on construction sites. They typically have significant experience in the construction trades. A construction supervisor usually reports to a site manager. Candidates for construction supervisor roles usually start by entering a construction trade and then further develop their skills and knowledge through experience.

Construction supervisors oversee the training and induction of staff and must have excellent verbal and written communication skills. Frequent dialogue between professionals such as surveyors, architects and estimators is key to ensuring that all project requirements are running on schedule. Construction supervisors are responsible for the efficient deployment of labour, construction machinery and building materials on a given project. They schedule work activities, document the amount of building materials used and make progress reports to management. Construction supervisors ensure that projects are completed on time and within budget.

A construction supervisor assesses construction site activity to ensure it complies with industry safety procedures. Construction supervisors must also guide workers towards safer and more effective working practices as and where required.

While work is taking place, the site supervisor will monitor progress, oversee delivery of materials, carry out safety checks and sort out any problems, which could hold up work as they arise. He or she will also ensure that work complies with building regulations and health and safety legislation as well as other legal requirements.

Learners must understand the transferable skills needed to carry out site supervisory activities and be able to apply them to a range of tasks.

## Learning outcomes

In this unit, learners will be able to

1. determine the supervision of labour and resources on construction sites
2. understand the roles and responsibilities of site supervisors
3. use appropriate project documentation for construction projects

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Determine the supervision of labour and resources on construction sites

### Topics

- 1.1 The construction team
- 1.2 Resource management

#### Topic 1.1

Learners must understand the position of the construction site supervisor within the construction team (client, architect, other designers and professionals, main contractor, subcontractors, crafts persons and operatives) in terms of:

- motivation
- communications
- codes of conduct
- team integration
- management of subcontractors
- training and development of skills.

#### Topic 1.2

Learners must understand the techniques used to supervise labour and control resources for construction projects. These must include, for labour:

- bonuses, incentives
- working with the client and the architect, liaising with day-work staff
- professional ethics, company image
- meetings, updates, toolbox talks
- rules and regulations, contracts
- CPD, development, adequate supervision.

Learners must also consider how the following relate to resource management, including waste management:

- material ordering and storage
- lean construction
- tools and equipment management
- waste management
- effective storage procedures, protection of material, security, requisitioning
- just-in-time deliveries, effect of weather conditions
- spot-checks, penalties, faulty goods, reporting policy
- waste segregation, reclaiming, recycling, reusing.

### Learning outcome:

#### 2. Understand the roles and responsibilities of site supervisors

### Topics

- 2.1 Management function
- 2.2 Personal attributes

## 2.3 Risk management techniques

### Topic 2.1

Learners must understand the various methods used to communicate efficiently and effectively with labour on site. Liaising with staff members over regular intervals is essential to ensure smooth running of a project and must include:

- meetings, client briefings
- liaising with architects, HSE, local police, councils, local residents, building inspectors
- role of CDM co-ordinator, environmental bodies

Learners must understand the different tasks that a supervisor will carry out during a project. These will include:

- hire of labour
- snagging lists
- handover procedures
- contractor queries
- data concerns
- connection and termination of services
- health and safety training
- quality control
- materials management
- day-to-day management of site procedures
- advice on finance and interim payments.

### Topic 2.2

Learners must understand the personal attributes and skills required of an effective site-supervisor. These will include:

- technical knowledge
- interpersonal
- communication
- negotiation
- organisational and planning
- motivational

### Topic 2.3

Learners must be able to apply appropriate techniques to ensure that everyone involved in a construction project is managed in a manner that ensures full compliance with any risk assessment techniques used. These will include risk assessment forms, method statements and company policies and procedures.

Procedures used to ensure compliance with the above include:

- safe systems of work
- induction and training
- appropriate signage
- checklists
- safety inspections
- permits to work.

## Learning outcome:

### 3. Use appropriate project documentation for construction projects

#### Topics

- 3.1 Working with project documentation
- 3.2 Resource procurement

#### Topic 3.1

Learners must understand the essential documentation required to manage and co-ordinate construction projects. Learners must be able to differentiate between the different pieces of information used for such projects, including the following.

- Working drawings
- Specifications
- Schedules
- Bill of Quantities
- Programme of works
- Method statements
- Risk assessments
- Site diary / progress reports
- Gantt charts
- Progress charts

#### Topic 3.2

The learner must understand the role of the construction supervisor in procuring the following resources:

- materials (requisitioning, checking orders, receiving goods, quality control, storage, stock control, documentation)
- labour (site staff recruitment only)
- plant and equipment hire.

## Guidance for delivery

Staff delivering this unit will have an opportunity to use a wide range of techniques, lectures, guest speakers/industry experts, discussions, case studies, use of DVD and video footage.

Centres should stock a wide range of masonry products and material that involves brickwork activities to show and demonstrate to learners. Real life industry visits to encourage debate, discussion and allow learners to experience the environment.

Staff are advised to use seminar presentations, site visits, supervised practical activities, research using internet and/or library resources and the use of personal and or industrial experiences are suitable.

Delivery of this unit should stimulate, motivate, educate and enthuse the learner. Visiting guest speakers could also add to the relevance of the subject to bring the learning to life.

UAN:	T/506/5415
Level:	3
GLH:	60

### What is this unit about?

People have limited control over the external environment, and the provision of human comfort in the internal environment is therefore of critical importance in modern construction. This has obvious implications for energy efficiency and sustainability, and it therefore follows that these issues require careful consideration at an early stage of design and construction.

Electricity is vital to the way we work and live today, and has been for a very long time. The distribution of electrical power within buildings will be covered in **Unit 310: Building Services Technology**. The generation of electrical power, and the distribution of that power to buildings, is dealt with here. This unit covers the processes used to generate electricity in power stations, using a source of heat to produce steam to drive turbines. The production of electricity by alternative sources such as wind, water and the tides is covered in Unit 318: Sustainability and new technologies.

Construction materials are used for a wide variety of purposes. Some are structural, others are decorative, others provide a smooth, clean, hygienic finish, some conduct electricity well and others provide thermal insulation. These are only a few of the uses to which construction materials can be put. The unit identifies the construction materials in general use and explains the important properties of each. The use to which materials are put depends upon their fitness-for-purpose, and this in turn depends upon their physical and chemical properties. The link between the intended purposes of the materials, the environment in which they will be used, their properties, and their final specification as both sustainable and fit-for-purpose, will be emphasised throughout.

Despite all of this, materials can deteriorate in use and may eventually fail. This unit identifies how and where this can happen, and explains the methods and techniques used to reduce, prevent and, where necessary, remediate, such deterioration

### Learning outcomes

In this unit, learners will be able to

1. identify the factors that affect human comfort in buildings
2. understand the safe generation, transmission and distribution of electrical power
3. determine the properties and uses of construction materials
4. recognise how construction materials fail and how such failures can be prevented

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Identify the factors that affect human comfort in buildings

### Topics

- 1.1 Thermal comfort
- 1.2 Lighting
- 1.3 Noise and vibration

#### Topic 1.1

Learners must be aware that human comfort varies from person-to-person but that the factors that affect the perception of comfort can be considered systematically. They must understand the effect of each factor and be able to state acceptable values for each of the factors. There is no requirement for the learners to understand combined thermal comfort scales or calculate standard design temperatures.

- Environmental factors (air temperature, mean radiant temperature relative humidity, air velocity)
- Individual factors (age, gender, health, activity, clothing)
- Acceptable range of values and appropriate units for above
- Measurement of factors (thermometers, hygrometers, anemometers)
- U values and their relevance to human comfort
- Calculations relating to above.

#### Topic 1.2

Learners must be aware of the different properties of natural and artificial lighting, and must be able to specify both in qualitative and quantitative terms. They must be able to recognise different types of luminaire, but there is no requirement for them to demonstrate an understanding of how the different types of luminaires work, or the nature of the light distribution provided by each, at this stage.

- Artificial lighting (types of luminaires)
- Natural lighting (daylight)
- Acceptable range of values and appropriate units for above
- Glare
- Measurement of factors (light meter, daylight meter)
- Calculations relating to above.

#### Topic 1.3

Learners must demonstrate an understanding of the effect of noise and vibration on human comfort and be able to state acceptable values for each and explain how loudness and frequency interact. They must understand the difference between the insulation and absorption of sound, but there is no requirement for an in-depth understanding of the techniques used to control sound transmission or reverberation.

- Loudness and frequency
- Absorption and insulation
- Acceptable range of values and appropriate units for above
- Measurement of factors (sound level meter)
- Calculations relating to above.

### Learning outcome:

## 2. Understand the safe generation, transmission and distribution of electrical power

### Topics

- 2.1 Principles of electricity
- 2.2 Generation of electrical power
- 2.3 Transformation and distribution of electrical power

#### Topic 2.1

Learners must be aware of what is meant by the term 'electric current' and must understand the relationship between voltage, current, resistance, electrical power and the work done by an electric current. They must understand the basic principles of electromagnetic induction, and how this can be used to generate electrical power for large-scale use. They must be able to develop this understanding to demonstrate why alternating current is the inevitable outcome of standard practical methods of generating power.

- Electric current as a flow of electrons
- Relationship between volts, amperes, ohms, joules and watts.
- Electro-magnetic induction
- Reason why current alternates in direction
- Alternating current wave form (characteristics, peak values, root-mean square values)
- Calculations related to above.

#### Topic 2.2

Learners must understand practical methods of generating electricity in terms of what goes on in power stations. There is no requirement at this stage for an understanding of alternative or renewable forms of generating energy, although they should be aware that they exist.

- Sources of heat energy (coal, oil, gas, nuclear, biomass)
- Awareness of renewable energy sources
- Process of generating electrical power
- Calculations related to above.

#### Topic 2.3

Learners should understand that the distribution of electrical power at high voltages implies high power losses and that the distribution of electrical power to buildings at high voltages is unsafe and will create practical problems. This should be reinforced by calculation of power losses at a variety of voltages. Learners must understand the consequent need for transformers and be able to explain how they work. This too should be reinforced by calculations. They must understand the advantages of three-phase distribution over single-phase distribution and be able to draw simple combinations of live and neutral phases to demonstrate how both 230/240 V and 415 V supplies can be provided.

- Power losses during transmission
- Transformation of electrical power (step-up and step-down transformers)
- Single-phase and three-phase distribution
- Calculations related to above

### Learning outcome:

## 3. Determine the properties and uses of construction materials



## Topics

- 3.1 Materials
- 3.2 Properties
- 3.3 Uses

### Topic 3.1

Learners must be able to recognise the common materials used in construction and be able to explain where each is generally used and for what purpose. There are many other materials that can be used, but the following are the most common.

- Timber
- Bricks and blocks
- Cement, aggregates and concrete
- Metals and alloys (steel, copper, lead, aluminium)
- Limes and gypsum plasters
- Plastics

### Topic 3.2

Learners must understand the important properties of construction materials and be able to explain why and where each is important. They must develop a qualitative understanding of these properties (for example, that steel has a greater density than aluminium, or that the thermal expansion of plastics is greater than that of timber) but there is no need for an exact quantitative knowledge of the value of each.

- Strength (compressive, tensile, shear, bending)
- Modulus of elasticity (stiffness)
- Density (solid and bulk)
- Durability (resistance to chemical, physical and biological attack)
- Workability
- Porosity and water absorption
- Thermal and moisture movement
- Thermal and electrical conductivity

### Topic 3.3

Learners must develop an understanding of how the properties of materials directly influence the way in which materials are used and how specification follows upon fitness-for-purpose in every case. Costs should be considered only in relative terms.

- Fitness for purpose (structural, water-exclusion, thermal and sound insulation; electrical conduction and resistance),
- Aesthetics (visual appearance), resistance to degradation, contribution to sustainability
- Costs, ease of handling and working, health and safety issues
- Specification to reflect properties in use

## Learning outcome:

- 4. Recognise how construction materials fail and how such failures can be prevented

## Topics

- 4.1 Causes of failure
- 4.2 Failure mechanisms

### 4.3 Preventive techniques

#### Topic 4.1

Learners must be able to recognise the agents that lead to the failures of construction materials and must be able to explain which materials they will most affect.

- Water
- Sunlight
- Insect attack
- Fungal attack
- Chemical attack
- Fire
- Temperature (degradation by heat, frost attack)

#### Topic 4.2

Learners must understand how the agents identified above are instrumental in the deterioration and failure of construction materials. They must be able to explain the scientific principles underpinning such deterioration (for example, corrosion of metals is an electro-chemical process, fungi attack timber because they contain no chlorophyll, frost attack on porous materials is the result of water expanding as it freezes, and so on) but only at a level commensurate with a general understanding of the hazards to which materials are exposed.

- Corrosion of metals
- Fungal and insect attack on timber
- Warps, splits and shakes in timber
- Frost attack on brickwork and concrete
- Sulphate attack on cements
- Efflorescence in brickwork
- Ultra-violet attack on paints and plastics.

#### Topic 4.3

Learners must build upon the above to understand that all materials deteriorate in use and that great care must be taken in the specification of materials, and that this must be backed up with preventive measures and remediation as necessary.

- General (provide physical barrier, painting, coating)
- Corrosion (exclude water and air, sacrificial coating, cathodic protection, anodisation)
- Fungal and insect attack (apply preservatives, control moisture content)
- Warps, splits and shakes in timber (appropriate form of conversion, air or kiln seasoning)
- Frost attack (exclusion of water, specification of low porosity materials)
- Sulphate attack on cements (specify sulphate-resisting cements, exclusion of groundwater)
- Efflorescence (exclude water, use bricks with low soluble salt content)
- Ultra-violet attack (incorporate UV stabilisers in plastics)

### Guidance for delivery

Tutors have opportunities to use a wide range of techniques. These should include lectures, small and large group discussions, case studies, demonstrations, supervised laboratory practical work, research using the internet and/or other library resources and presentations by guest speakers. Delivery should stimulate, motivate, educate and enthuse learners.

Centres would benefit from visits to building sites, power stations and materials testing centres. The use of case studies, DVDs, videos and photographic material will be useful as a secondary source of data, should first-hand experience of testing procedures prove difficult.

Learning outcomes 3 and 4 are, although separate, linked in a fairly obvious way and it is recommended that they be taught in the obvious order, so that the content of L<sub>3</sub> can be fully utilised in the delivery of LO<sub>4</sub>.

Teaching and learning strategies should take an integrated approach and must combine learner-centred investigative techniques with supervised, hands-on, experiential learning that involves taking measurements, making observations, consulting reference documents and forming conclusions. Practical demonstrations and laboratory work should be used to underpin the measurement of the factors that affect human comfort and the generation and distribution of electrical power. The latter should be small in scale and should concentrate on the principles. Centres should use power packs, rather than mains supplies, to reduce the risk to learners. Materials testing procedures are useful, where the centre possesses the relevant equipment, but experiments can be simulated without recourse to specialist equipment. Health and safety risk assessments should, of course, be undertaken before each testing procedure.

Calculations are unavoidable in science-based units and are explicitly included in learning outcomes 1 and 2. The use of calculations to support the other learning must not however be seen as an exercise in its own right. This content of this unit underpins that of many other units and the unit should generally be undertaken at an early stage of the programme. Group activities are permissible, and indeed encouraged, but tutors must ensure that learners are able to provide individual evidence of understanding.

UAN:	A/506/5416
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is to introduce learners to the practice of quantity surveying, measuring quantities, calculating budget costs and producing estimates to determine the value of building projects.

Learners will engage in calculating material quantities from construction drawings, in line with the New Rules of Measurement (NRM 2). The accurate measurement and description of building quantities is essential in preparing budgets costs and producing Bills of Quantities.

NRM 1 provides guidance on the quantifying of building works to produce a budget cost. It provides a set of rules for preparing cost estimates for the client. Learners will investigate the different measurement techniques used by quantity surveyors using NRM1.

Tendering and estimating uses a specific technical language and learners will need to learn this language in order to develop their skills within this subject. Learners will identify the different components needed to establish unit rates and put together a tender figure. They will learn specific terminology used and investigate how it fits into the tendering process. They will learn the job role of estimator along with the other parties involved within different tendering routes.

### Learning outcomes

In this unit, learners will be able to

1. measure quantities from construction drawings
2. prepare budget costs
3. understand the principles of tendering and estimating
4. build up a tender figure

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Measure quantities from construction drawings

##### Topics

- 1.1 Measurement rules
- 1.2 Bill production

##### Topic 1.1

Learners must use standard mensuration techniques to produce accurate measurements from construction drawings (running metres, areas, volumes). Learners will need to use, RICS NRM (New Rules of Measurement) to prepare standard descriptions and accurate measurements for various domestic construction activities including:

- substructure to DPC
- walls
- floors
- roofs.

Traditional dim paper should be used. However, where centres have access to measurement software learners should be given the opportunity to use the software for taking dimensions. NRM2, is the current rule book with regard to measuring construction projects and learners need to familiarise themselves with the rules laid down in this book.

##### Topic 1.2

Bills of quantities can be produced using:

- different formats
- elemental works sections
- work packages.

Learners should discuss the advantages/disadvantages of the different ways of producing bills of quantities. Traditional Bill production has been superseded by computer programmes. Where centres have access to such programmes learners would benefit from producing their own simple bills, or bill pages.

### Learning outcome:

#### 2. Prepare budget costs

##### Topics

- 2.1 Approximate estimating techniques

##### Topic 2.1

The quantity surveyor has the responsibility to provide cost analyses throughout the duration of the building project. As part of the feasibility and early planning stages of a project the quantity surveyor will use different techniques (depending upon the information available) to provide initial cost plans for the client. Learners must compare the different techniques used and investigate the information needed for each, and compare costs in terms of accuracy and timescale. NRM1 provides guidance on the quantification of the building work required to build up cost plans. Cost

plans are a continuous process and NRM2 links these directly to the different stages of the RIBA Plan of Work.

Methods used include the:

- functional unit method
- superficial method
- approximate quantities
- elemental cost planning

### Learning outcome:

#### 3. Understand the principles of tendering and estimating

##### Topics

##### 3.1 Terminology

##### 3.2 Comparison of different tendering routes

##### Topic 3.1

The subject of tendering and estimating uses a specific technical language. In order for learners to develop their knowledge of this subject they need to understand this language and how each subject fits into the tendering and estimating process. Learners must look at various trades when working up unit rates and establishing labour charges. The following terms must be considered.

- Tender
- Estimate
- Net and gross figures
- Prime Costs and Provisional Sums
- Material costs
- All-in labour rate
- Labour outputs/ constants
- Plant costs
- Overheads and on-costs
- Preliminaries
- Unit rates
- Profit
- Sub- contractors
- Adjudication meeting
- VAT

##### Topic 3.2

Learners must compare different tendering routes such as traditional tendering (single-stage and two-stage), negotiated tendering and open tendering in terms of;

- advantages and disadvantages of each
- where and when each is used
- costs
- timescales
- documentation
- type of construction project
- type of client
- type of building
- current practice.

## Learning outcome:

### 4. Build up a tender figure

#### Topics

- 4.1 Produce tender figures for given scenarios
- 4.2 Commercial factor

##### Topic 4.1

The learner must put together a tender figure for a given scenario. They must produce a tender timetable, work up unit rates for construction activities, PC and provisional sums, preliminaries, sub contract items and apply overheads and profit. Learners will be made aware of documentation to be used and the time constraints that would exist in industry. The stages must be:

- Produce a tender timetable
- Price up measured work
- Price up preliminaries
- PC and Provisional Sums
- Apply overheads and profit
- Look at timescales and documentation

##### Topic 4.2

Learners must understand that, before any contractor decides to accept a tender proposal, important commercial decisions have to be made concerning:

- time constraints
- start date
- complexity
- known contractors
- new contractors
- type of contract to be used
- location
- workload

Learners must understand the factors that affect the decision to tender and the types of risk to be taken into account before a figure is agreed for the profit to be added to the estimate. The following factors must be considered when finalising the profit:

- buoyancy of the industry
- client
- contract
- timescale
- size of liquidated damages
- parties involved.

## Guidance for delivery

Tutors have opportunities to use a wide range of techniques. These should include lectures, small and large group discussions, case studies, demonstrations, research using the internet and/or other library resources and presentations by guest speakers. Delivery should stimulate, motivate, educate and enthuse learners.

Teaching and learning strategies should take an integrated approach and must combine learner-centred investigative techniques with supervised, hands-on, experiential learning that involves working from original documentations (real life drawings, specifications and Bills of Quantities), making observations, consulting reference documents and forming conclusions.



<b>UAN:</b>	J/506/5418
<b>Level:</b>	3
<b>GLH:</b>	60

### **What is this unit about?**

The purpose of this unit is to further develop the learners understanding of the principles of site surveying and the skills to set out construction projects. The unit also develops learners understanding of the modern instruments and software used in the construction industry.

The unit introduces the types of surveying and setting out work undertaken on construction sites and requires learners to demonstrate understanding of the unit by completing a variety of both practical and written assignment task components. In addition, the unit is intended to offer learners a qualification from which to enter, at technician level, in a variety of professions from land surveyor, architectural, building construction or civil engineering technician.

### **Learning outcomes**

In this unit, learners will be able to

1. understand the principles of surveying and setting out
2. use surveying equipment for surveying processes
3. use and apply surveying data for setting out processes
4. recognise the benefits of modern software application

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Understand the principles of surveying and setting out

### Topics

- 1.1 The different types of traverse
- 1.2 Bowditch method of correction
- 1.3 Procedure and instruments used in the transferring of control points
- 1.4 Procedures for the design of large horizontal curves
- 1.5 Use of modern electronic surveying instruments

#### Topic 1.1

Learners must be able to differentiate between the following types of traverse and should understand the factors that make them different.

- Open traverse
- Link traverse
- Closed traverse

#### Topic 1.2

Learners must understand the Bowditch method in terms of:

- Its purpose
- Its use
- The need for all linear and angular measurements to be compatible with each other

#### Topic 1.3

Learners must understand the purpose of:

- Base datum level
- Temporary Bench Marks (TBMs)

Learners must recognise the following instruments and be able to set them up for use.

- Optical plumbing instruments
- Theodolites
- Total stations
- Construction laser
- Dumpy level
- Auto-plumb
- Plumb bob

#### Topic 1.4

Learners must be able to use the following staged procedures to design large radius horizontal curves.

- Intersection point
- Tangent points
- Chainage
- Tangential angle

- Long chord

### Topic 1.5

Learners should be aware of the use and purpose of the following types of surveying instruments used in civil engineering projects:

- Electronic Distance Measurement (EDMs) devices
- Total Station instruments
- Electronic data loggers
- GPS (Global Position Satellites)
- GIS (Geographical Information Systems)
- Laser levels
- Digital terrain modelling

## Learning outcome:

### 2. Use surveying equipment for surveying processes

#### Topics

- 2.1 Terminology associated with horizontal and vertical control
- 2.2 Set up and use of surveying instruments
- 2.3 Adjustment procedures used for levelling and angular measuring surveying instruments
- 2.4 Production of contoured plans from completed levelling surveys

### Topic 2.1

Learners must recognise and be able to define the following terms:

- Base line
- Stations
- Traverse
- Triangulation
- Trilateration
- Grid
- Intersection
- Resection

### Topic 2.2

Learners must be able to set up and use the following equipment.

- Steel bands
- EDM devices
- Automatic level
- Tilting level
- Laser level
- Theodolites (either or both optical and electronic)
- Total Station instruments

### Topic 2.3

Learners must be familiar with the following adjustment procedures (temporary and permanent) for levelling and angular measuring surveying instruments.

- Levelling: Setting up and centralising bubble, two peg test, adjustment of bubble tube

- Angular measurement: Set up, face left/face right, plate level, horizontal axis, line of collimation adjustments

Learners must have an understanding of the following terminology when carrying out surveying and setting out processes

- Deflection angle
- Chainage
- Intersection point
- Chord lengths

#### Topic 2.4

Learners must be able to convert the data from completed levelling surveys into contoured plans using either:

- Manual drafting
- CAD techniques

### Learning outcome:

#### 3. Use and apply surveying data for setting out processes

##### Topics

- 3.1 Calculation of co-ordinates for traverse stations and application of corrections
- 3.2 Determination of cut and fill requirements from contours, plan or horizontal section details
- 3.3 Setting out large radius horizontal curves from data provided

#### Topic 3.1

Learners must take the following into consideration when using and applying surveying data for setting out purposes.

- General terminology (Whole Circle Bearings, Bowditch method)

#### Topic 3.2

Learners must be able to use standard formulae to calculate cut and fill quantities from drawings using:

- Simpson's Rule
- Trapezoidal Rule

#### Topic 3.3

Learners must understand how to set out horizontal curves using the following:

- terminology (deflection angle, chainage, intersection point, chord lengths)
- calculations (computation of deflection angles, calculation of chord lengths)

### Learning outcome:

#### 4. Recognise the benefits of modern software applications

##### Topics

- 4.1 Benefits and use of the software built into total stations to aid setting out
- 4.2 Advantages of GPS systems and their application to civil engineering works

### 4.3 Computer software to solve typical surveying problems

#### Topic 4.1

Learners must understand the general benefits of the software incorporated into total stations, including:

- Reduced errors
- Shorter surveying time
- Increased accuracy
- Increased precision of data

#### Topic 4.2

Learners must understand the general benefits of GPS, including:

- Global accessibility
- Increased efficiency
- Increased accuracy
- Increased speed

#### Topic 4.3

Learners must investigate how the following software is used in solving typical surveying problems.

- GIS (Geographical Information Systems)
- OS digital data (Ordnance Survey)
- CAD (Computer-Aided Design)

### Guidance for delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practical, research using the internet and/or library resources and use of personal and/or industrial experience are all suitable.

Supervised practical work should predominate where possible to assess Learning Outcomes 2-3. Written scenario led contextualised assignment briefs should be incorporated to assess Learning Outcomes 1, 4 and 5 although centres should also consider learner presentations as a way to convey their understanding.

Delivery should stimulate and enthuse learners. Visiting expert speakers could add to the relevance of the subject especially in relation to the modern surveying instruments currently being used on construction sites.

The five learning outcomes are not linked to each other but there is a natural progression from basic linear surveys, through levelling, angular measurements and setting out activities, to the use of modern surveying equipment.

Group activities are an important part of the assessment of practical aspects of this unit, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

<b>UAN:</b>	F/506/5420
<b>Level:</b>	3
<b>GLH:</b>	60

### **What is this unit about?**

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.

The unit introduces the analysis of beams, columns, frameworks and retaining walls structural concepts and develop skills to determine properties of typical structure materials. In addition, the unit is intended to offer learners a qualification from which to enter, at technician level, a variety of professions from civil engineering, structural engineering or other building technician role where understanding of this unit would be beneficial.

### **Learning outcomes**

In this unit, learners will be able to

1. determine shear force values, bending moments and deflections for simple structures
2. design simple beams and columns
3. calculate factors of safety and pressures acting on retaining walls
4. determine forces acting in statically determinate frames for various loading conditions

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Determine shear force values, bending moments and deflections for simple structures

##### Topics

- 1.1 Calculations of reactions, shear force and bending moment values for various positions on a beam
- 1.2 Drawing of shear force diagrams for various loading conditions
- 1.3 Production of bending moment diagrams for various loading conditions
- 1.4 Calculation of mid-span deflections for simply supported beams

##### Topic 1.1

Learners must understand the use of the principle of moments and the laws of static equilibrium to determine beam reactions for the following types of beam:

- Simply supported beams with or without overhangs at one or both ends
- Cantilevers

Learners should be able to determine reactions top beams, shear force values and bending moment values for the above beams under the following loading systems:

- Point loads
- Uniformly distributed loads (UDLs)
- Combination of point and uniformly distributed loads

##### Topic 1.2 and 1.3

Learners must be able to convert the above into the following diagrams and be able to recognise the coincidence of associated points:

- Loading diagrams
- Shear Force diagrams
- Bending Moment diagrams
- Relevance of diagrams (coincidence of SF zero and BM maximum, importance of points of contraflexure)

##### Topic 1.4

Learners must recognise the various formulae used to determine the deflection at the mid-point of a beam and understand:

- why the deflection is considered important
- how the maximum allowable deflection is determined
- whether a beam is safe in deflection or not.

### Learning outcome:

#### 2. Design simple beams and columns

##### Topics

- 2.1 Calculations of first and second moments of area of different sections

- 2.2 Design of rectangular beam sections using the General Theory of Bending
- 2.3 Determination of safe load/section size for axially-loaded columns
- 2.4 Determination of stress values for eccentrically-loaded columns

#### **Topic 2.1**

Learners must understand the importance shape, as quantified by moments of area and recognise the formulae used to determine moments of area for the following sections

- Rectangular shapes
- Circular shapes
- Compound shapes

#### **Topic 2.2**

Learners should recognise the General Theory of Bending and use it to size rectangular beams. Learners must understand what is meant by the following terms and the importance attached to the consistent use of units.

- $M$  = maximum bending moment (Nm)
- $f$  = permissible stress (N/mm<sup>2</sup>)
- $I$  = moment of inertia or second moment of area (mm<sup>4</sup>)
- $y$  = depth of neutral axis (mm)

Learners must understand the use of permissible stress design tables to size timber and steel beams with the following sectional shapes:

- T-section
- I-section
- Channel

#### **Topic 2.3**

Learners must recognise the importance of the following terms in the design of axially-loaded columns:

- effective length
- moment of inertia
- cross-sectional area
- radius of gyration
- slenderness ratio

Learners must be capable of sizing columns made from:

- timber
- steel.

Learners should be able to design the following types of column:

- short columns
- long columns
- concrete columns
- columns of different sectional shape (solid, rectangular, H section, circular)

#### **Topic 2.4**

Learners must recognise the following effects of eccentric loading on columns and be able to calculate associated stresses.

- Direct stress
- Bending stress
- Total stress



### Learning outcome:

## 3. Calculate factors of safety and pressures acting on retaining walls

### Topics

- 3.1 Forces and pressures acting on retaining walls
- 3.2 Determination of factors of safety against sliding and overturning

#### Topic 3.1

Learners must understand how both active pressures and passive pressures can be generated on a wall due to retained:

- Soils
- Liquids

Learners must be able to determine the load bearing on the ground, and the position of action of that load, for

- Rectangular retaining walls
- Trapezoidal retaining walls

#### Topic 3.2

Learners must be able to differentiate between the following modes of failure and be able to determine factors of safety against both.

- Overturning (about the toe)
- Sliding

### Learning outcome:

## 4. Determine forces acting in statically determinate frames for various loading conditions

### Topics

- 4.1 Determination of magnitude and type of force acting in frames using graphical techniques
- 4.2 Calculation of magnitude and type of force acting in frames by resolution of forces

For all of what follows, learners must understand the importance of:

- Bow's notation
- Equilibrium at a joint
- The consistent direction of forces in a force polygon
- The application of loads only at the node points of the frame

#### Topic 4.1

Learners must understand how the following affect the graphical method:

- graphical representation of force as a vector
- accuracy of drawing
- a joint in equilibrium implies closed force polygons
- how the nature of the force acting in a member can be inferred from the direction of action at a node.

**Topic 4.2**

Learners must understand how the following affect the method of resolution.

- The principle of moments
- The laws of horizontal and vertical equilibrium
- How the nature of the force acting in a member can be inferred from the direction of action at a node.

**Guidance for delivery**

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, videos/DVDs, research using the internet or library resources and use of tutors with relevant and appropriate industrial experience are all suitable. Visiting expert speakers could add to the relevance of the subject for learners. This could include guest speakers who are members of the chartered institutions of structural mechanics and civil engineering.

The learning outcomes are sequential.

Group activities are permissible, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

UAN:	J/506/5421
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is to allow learners to develop an understanding of the methods used to perform deep excavations, control groundwater on site and construct substructure, external works and superstructure. Opportunities are provided throughout to explore the health and safety issues associated with civil engineering construction methods.

### Learning outcomes

In this unit, learners will be able to

1. recognise the methods used to carry out deep excavations and control groundwater on site
2. recognise the methods and techniques used in the construction of substructure and external works activities
3. recognise the methods and techniques used in superstructure activities
4. apply health and safety considerations in civil engineering

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Recognise the methods used to carry out deep excavations and control groundwater on site

### Topics

- 1.1 Temporary and permanent support methods for deep excavations
- 1.2 Temporary and permanent methods of controlling groundwater

#### Topic 1.1

Learners must understand and use appropriate technical terminology to describe the methods of temporary and permanent support used to perform deep excavations. They must be able to determine the most suitable form of deep excavation support for given scenarios. Methods of deep excavation include the following.

- Trench strutting
- Trench boxes
- Shoring
- Diaphragm wall
- Caissons
- Cofferdams
- Steel sheet walling

#### Topic 1.2

Learners must understand and use appropriate technical terminology to describe the methods used to ground water. They must be able to determine the most suitable form of groundwater control techniques for given scenarios.

Temporary methods include:

- Dewatering
- Sumps
- Pumps
- Well points
- Electro-osmosis
- Freezing
- Grouting
- Compressed air
- Cut off trenches

Permanent methods include:

- Tanking
- SUDS
- Land drains
- Sand drains
- Sheet piling
- Diaphragm walling ( and other walling methods)

### Learning outcome:

## 2. Recognise the methods and techniques used in the construction of substructure and external works activities

### Topics

- 2.1 Plant and equipment used in substructure and external work construction
- 2.2 Substructure and external works activities

#### Topic 2.1

Learners must understand and use appropriate technical terminology, and be able to produce sketch section details to demonstrate their understanding of the methods and techniques used in civil engineering substructure and external works activities. They must be able to determine the most suitable form of construction from given scenario situations. They must be aware of the advantages and limitations of the various construction methods available to them from case study or scenario situations. Plant and equipment could include, but should not be limited to:

- Excavators
- Scraper
- Grader
- Loader
- Piling rigs
- Cranes
- Concrete pumps
- Batching plant

#### Topic 2.2

Learners must have a fundamental understanding of the methods and techniques used in the following substructure activities.

- Types of foundation (pad, strips, trench fill, raft, piling)
- Drainage (pipe work, concrete culverts, inspection chambers)
- Utilities (services installation, service tunnels, ducts)
- Highway construction (flexible, rigid, composite)
- Retaining walls (mass, reinforced concrete, masonry)

### Learning outcome:

## 3. Recognise the methods and techniques used in superstructure activities

### Topics

- 3.1 Plant and equipment used in superstructure
- 3.2 Forms of superstructure

#### Topic 3.1

Learners must understand and use appropriate technical terminology, be able to produce sketch section details and to demonstrate their understanding of the methods and techniques used in civil engineering superstructure activities. They must be able to determine the most suitable form of construction from given scenario situations. They must be aware of the advantages and limitations of the various construction methods available to them. Plant and equipment could include, but should not be limited to:

- concrete pumps
- cranes (mobile/static)
- hydraulic access equipment
- formwork
- falsework
- scaffolding

### Topic 3.2

Learners must have a fundamental understanding of the following methods and techniques:

- Steel frame (columns, beams, pad and column connections, beam and column connections, composite floor decks)
- Concrete in situ frame (columns, beams, floors, formwork, composite floor decks)
- Portal frame construction (timber, steel, concrete)
- Basic bridge types and forms (simple span, beam, arch, truss, suspension, cantilever and cable-stayed)

## Learning outcome:

### 4. Apply health and safety considerations in civil engineering

#### Topics

- 4.1 Key health and safety legislation associated with civil engineering activities
- 4.2 Production of risk assessments

#### Topic 4.1

Learners must identify and outline key health and safety legislation and their associated relevance to scenario or case-study led civil engineering projects. This should include the following as they apply to civil engineering projects.

- Health & Safety at Work Act
- CDM Regulations
- Health & Safety Management Codes L21, L144
- Control of Substances Hazardous to Health (COSHH)

#### Topic 4.2

Learners are required to conduct a risk assessment of a small civil engineering project such as the one used for 4.1 above.

- Identify and explain the use of a standard format for identifying and recoding hazards.
- Identify hazards associated with a small civil engineering project.
- For each hazard produce a risk assessment which details the hazard, risk and method of controlling the risk.

## Guidance for delivery

Learning outcomes 1 to 4 are closely linked and can be delivered in conjunction with each other in an integrated assignment approach or in a series of separate contextualised assignment briefs which address each learning outcome. The use of construction drawings is encouraged to enable learners to see how the component parts of different forms of construction fit together.

Tutors have the opportunity to identify and describe a wide range of civil engineering activities from which plant and equipment, career opportunities and some basic construction related calculations may be completed. Lectures, discussions, case studies, the use of DVD or video material, site visits, work experience placement, research using the internet or other library facilities are all appropriate means of communicating aspects of the unit.

Reference to relevant legislation and standards should be made, as necessary, but there is no requirement for a detailed understanding at this level.

Centres would also benefit by establishing site visits to civil engineering projects and ideally to develop a relationship with a local civil engineering construction contractor or appropriate the departments of a local authority. This would offer opportunities for learners to make site visits (even regular visits) to view real-life experience of the construction progress.

UAN:	L/506/5422
Level:	3
GLH:	60

### What is this unit about?

Building services are the systems installed in a building to provide a safe, healthy and comfortable internal environment. These include hot and cold water, drainage, electricity and gas. Building services are essential to the health and comfort of people at work and in their homes. These building services do their job so well that we tend to take them for granted until something goes wrong. People turn on lamps, turn on the gas fire, flush toilets, put the kettle on to make a cup of tea or run hot water for a bath, without giving a moment's thought to how it all happens. Building services are distributed to buildings, and installed within buildings, by people working in the mechanical and electrical services sector. These people include building services engineers, electricians, plumbers and heating and ventilating engineers, among others. However, it is builders that construct the building within which the services are installed, it is builders that must understand how building services are integrated into buildings, and it is builders that must provide adequate access for maintenance and repair of the building services.

This unit is therefore intended specifically for those involved in the construction of buildings, rather than for those involved in building services. There are opportunities to explore the installation and distribution of hot and cold water, drainage, single-phase electricity and natural gas to low-rise buildings. This unit does not deal with space heating, ventilation, air conditioning, telecommunications, liquefied petroleum gas (LPG) or fire alarm and detection systems, nor does it cover temporary site services, extra-low voltage or special provisions for electrical installations. These are covered at a higher level or in other qualifications.

### Learning outcomes

In this unit, learners will be able to

1. determine the provision of electricity to buildings
2. determine the provision of hot and cold water to buildings
3. determine the provision of drainage to buildings
4. determine the provision of gas to buildings



## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Determine the provision of electricity to buildings

### Topics

- 1.1 Principles
- 1.2 Specification
- 1.3 Layouts

#### Topic 1.1

Learners must understand the basic principles that underpin the provision of single-phase electricity supplies, and must be able to propose practical applications of each of the following to ensure that the supply is safe and effective. The focus is on supply through the National Grid. Local supplies from renewable sources of energy are dealt with in **Unit 317: Sustainability and new technologies**.

- Entry into buildings
- Sufficient capacity
- Prevention of excess current
- Protection from electric shock
- Prevention of fire
- Safe means of isolation
- Installation and commissioning by 'competent person'

#### Topic 1.2

Learners must understand the purpose of each of the following and be able to specify each appropriately for a range of installations.

- Main service fuse
- Electricity meter
- Mains switch
- Consumer control unit
- Residual current devices
- Miniature circuit breakers and fuses
- Earth connections
- Outlet sockets
- Fused plugs and appliances

#### Topic 1.3

Learners must understand the different layouts used for the following and be able to produce line diagrams of the layouts.

- Ring final circuits for power (earthed, maximum 100 m<sup>2</sup>, limits on number of spur outlets, 32 A fuse or circuit breaker)
- Radial circuits for lighting (loop-in method, 6 A fuse or circuit breaker)
- Radial circuits for high power appliances – cookers (32 A fuse/cb), showers (32 to 40 A fuse/cb), immersion heaters (16 A fuse/cb)

### Learning outcome:

## 2. Determine the provision of hot and cold water to buildings

### Topics

- 2.1 Principles
- 2.2 Specification
- 2.3 Layouts

#### Topic 2.1

Learners must understand how cold water enters the building and the arrangements made to prevent the water freezing. They should be aware of the advantages and disadvantages of direct and indirect systems for distributing cold water and must be able to explain which system is preferred today, and why. Details of the techniques used to install cold water supplies are not a requirement of this unit.

Learners must understand how cold water is heated to provide hot water and the arrangements made to ensure that this is done safely. They should be aware of the advantages and disadvantages of direct and indirect systems for distributing hot water and must be able to explain which system is preferred today, and why. Details of techniques used to install hot water systems are not a requirement of this unit.

- cold water: entry to buildings, prevention of freezing, characteristics of direct and indirect systems, loadings, legal requirements, point at which responsibility transfers from water company to householder
- hot water: hot water generators (boilers), pressurised systems, characteristics of direct and indirect systems, arrangements to accommodate expansion of water, safety requirements

#### Topic 2.2

Learners must be able to specify hot and cold water systems in terms of the following:

- dimensions, capacities, storage, materials, components (water meters, stop-valve, drainage valve, isolating valves)

#### Topic 2.3

Learners must be able to produce simple line diagrams to show the distribution of each of the following from entry to point of use:

- cold water: direct and indirect systems
- hot water: direct and indirect systems

### Learning outcome:

## 3. Determine the provision of drainage to buildings

### Topics

- 3.1 Principles
- 3.2 Specification
- 3.3 Layouts

#### Topic 3.1

Learners must understand the difference between above-ground and below-ground drainage, and between surface water and foul water drainage. They must understand why the following

principles are important, and how each principle is addressed in practical terms. This unit does not deal with discharge to, or treatment in, septic tanks or cess pits.

- **Above-ground:** water seals, prevention of disruption of water seals by siphonage, need for ventilation, protection from frost, flow under gravity, exit from building for foul water drainage (not run under foundations without reinforcement), harvesting of surface water (grey water) for specific purposes
- **Below-ground:** capacity, gradient (fall), ventilation, support, access at changes of direction (inspection chambers, manholes, rodding points), design to minimise length of pipe runs, all junctions oblique and in the direction of flow, separate and combined systems for surface and foul water, point at which responsibility transfers from householder to water company

### Topic 3.2

Learners must be able to specify drainage systems in terms of the following:

- Dimensions, capacity, gradients, diameters, junctions, access, materials used

### Topic 3.3

Learners must be able to produce simple line diagrams to show the disposal of each of the following from a property to a sewer, watercourse or soakaway:

- Above-ground drainage: single stack and two-pipe systems
- Below-ground drainage: design for self-cleansing flow

## Learning outcome:

### 4. Determine the provision of gas to buildings

#### Topics

- 4.1 Principles
- 4.2 Specification
- 4.3 Layouts

#### Topic 4.1

Learners must understand the basic principles that underpin the provision of gas supplies, and must be able to propose practical applications of each of the following to ensure that the supply is safe and effective. The focus is on supplies of natural gas. Liquefied Petroleum Gas (LPG) supplies are not covered in this unit.

- Entry into building, reason for required depth of 375 mm
- Arrangements to deal with condensation
- Need for adequate supply of air to support combustion
- Flues, ventilation requirements (balanced and fan-diluted flues)
- Installation and commissioning by 'competent person'

#### Topic 4.2

Learners must understand the purpose of each of the following and be able to specify each appropriately for a typical installation.

- Gas main
- Service pipe (not run under foundations, or in cavities or unventilated voids; sleeved if passing through wall or floor)
- Control lever (on/off)
- Gas meter (internal or external)

- Controls

### Topic 4.3

Learners must be able to produce simple line diagrams to show the distribution of gas from entry to each of the following.

- Gas-fired central heating boiler
- Gas cooker
- Gas fire

## Guidance for delivery

Tutors have opportunities to use a wide range of techniques. These should include lectures, small and large group discussions, case studies, demonstrations, supervised laboratory practical work, research using the internet and/or other library resources and presentations by guest speakers. Delivery should stimulate, motivate, educate and enthuse learners.

Centres would benefit from visits to building sites, power & nuclear stations and materials testing centres. The use of case studies, DVDs, videos and photographic material will be useful as a secondary source of data, should first-hand experience of testing procedures prove difficult.

Teaching and learning strategies should take an integrated approach and must combine learner-centred investigative techniques with supervised, hands-on, experiential learning that involves, making observations, consulting reference documents and forming conclusions. Group activities are permissible, and indeed encouraged, but tutors must ensure that learners are able to provide individual evidence of understanding.

UAN:	R/506/5423
Level:	3
GLH:	60

### What is this unit about?

This unit will allow learners to develop their graphical communication skills utilising traditional manual drawing skills and modern computer aided drawing methods. In construction one of the key methods of communicating ideas is through the use of drawings. This ranges from quick sketches on site, to illustrate an idea, through to a fully rendered 3D model showing exactly how a building will look in the exact location in which it is sited.

On completion of the unit learners will be able to produce plans, elevations, sections, sketches, and 3D models of buildings and components. In addition to this, learners will acquire an awareness of modern developments within the industry such as BIM and 3D surveying, and an appreciation of the interaction between site work and the drawing office.

To deliver this unit centres will need access to both traditional drawing boards, up to A2 size and computer aided drawing software. There is no specific CAD package recommended however, this unit cannot be taken without access to the software

### Learning outcomes

In this unit, learners will be able to

1. use equipment and processes involved in manual drafting
2. use equipment and processes involved in computer-aided drafting
3. develop an awareness of Building Information Modelling (BIM)

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved. Learners will not need any prior knowledge of construction and the built environment in order to understand this unit but they should have basic numeracy and literacy skills.

### Learning outcome:

#### 1. Use equipment and processes involved in manual drafting

### Topics

- 1.1 Drawing office equipment
- 1.2 Development of drawing skills
- 1.3 Production of construction drawings

#### Topic 1.1

Learners should be aware of the wide range of drawing equipment and media used in the production of manually drafted drawings. These should include the following.

- Drawing boards
- Tee square
- 60°/ 30° and 45° and adjustable set squares
- Board clips/drafting tape
- Pencils/pens
- Compasses
- Scale rule
- Protractor
- Eraser
- French curves
- Drawing paper
- Tracing paper

#### Topic 1.2

Learners must develop a range of the skills required to produce appropriate construction drawings. This will include drawing practice to develop specific skills and the application of these skills to produce a range of drawings in accordance with British Standards and other standard conventions. Learners will need to be aware of, produce and use the following.

- Drawing scales and where each scale is used
- Drawing types (plans, elevations, sections, block plans, site plans, component, location, assembly drawings, sketches)
- Line types
- Dimension lines
- Hatching
- Symbols
- Lettering techniques
- Setting up a drawing (borders, title blocks)
- Methods of projection (orthographic (first angle, third angle), isometric, axonometric, oblique)
- Angles and division of angles using compasses
- Regular shapes (circles and component parts, squares, triangles, polygons, trapezium, parallelogram, ellipse)
- Solid shapes (cube, cuboid, triangular, cylinder, cone, sphere)
- Arches (segmental, lancet, 3 centred)

### Topic 1.3

Learners are required to produce a range of accurate scale construction drawings. The drawings should be construction related and cover the range of drawing used for a live project using a range of media. This will include the following.

- Floor plans to different scales to a range of building types
- Detailed sections through whole buildings and of specific construction components (sub-structure, superstructure to eaves, roof and floors)
- Elevations, to different scales and building styles

Learners will also need to have an awareness of the following:

- Component drawings
- Site plans
- Block plans
- Orthographic, isometric and axonometric pictorial drawings
- Freehand and rule assisted sketches to approximate scale

## Learning outcome:

### 2. Use equipment and processes involved in computer-aided drafting

#### Topics

- 2.1 Computer-aided design
- 2.2 2D drafting using computer-aided design
- 2.3 3D drafting using computer-aided design

### Topic 2.1

Learners should be aware of the range of computer drawing software packages available, and the hardware required to run them. They do not need an in-depth working knowledge of each system, but they do need to know that there is a range of options, and that these vary considerable in complexity and cost. This will include, but should not be limited to,

- Autodesk AutoCAD
- Autodesk AutoCAD LT
- Autodesk Revit
- Autodesk 3D Max
- Autodesk Inventor
- Solidworks
- Bentley Microstation
- ArchiCAD
- Vectorworks
- Tekla
- Sketch up
- CAD freeware

### Topic 2.2

Learners must produce drawings using computer-aided drawing software. There is no prescribed software. However, learners are expected to use, manipulate and produce the range of drawings listed in 1.3. Learners should be aware of:

- drawing set up, line types, line styles, layers
- drawing tools

- modify tools
- blocks
- dimensioning
- annotation
- hatching
- viewports and model space
- plotting

### Topic 2.3

Learners are required to produce 3D models of buildings and components within buildings. There is no requirement to produce highly-detailed rendered models, but there is a requirement to produce accurate models which have been rendered with a range of construction materials. This should include

- rendered external elevation models
- rendered section models.

## Learning outcome:

### 3. Develop an awareness of Building Information Modelling (BIM)

#### Topics

- 3.1 Uses and purposes of BIM
- 3.2 Integration and application of BIM

### Topic 3.1

Learners need to be aware of BIM and how it is used in the built environment today. BIM is not a software package, a computer-generated 3D model of a building, or even a method of simulation, communication or sharing data. It is a collaborative integrated approach to building design, construction and management through the whole life-cycle. Learners should know the advantages of BIM and how it is used on projects. This should consider:

- 3D Modelling
- change management
- building simulation
- data management
- building operation.

Learners should be aware of the historical development of BIM and the requirements for the integration of BIM being driven by the government. They also need to understand the different software packages used and how these integrate with each other and the different stages of the process.

### Topic 3.2

Learners should be aware of the integration of BIM processes into a project. This should be done by comparing and contrasting BIM with traditional methods of building design and management. They should be aware of the different levels of adoption and the benefits derived at each stage.

This will include:

- BIM Stages: maturity levels (Level 0, Level 1, Level 2 and Level 3), 2D, 3D, 4D, 5D, 6D
- COBie



- BIM RIBA Plan of works overlay
- PAS1192
- BIM Protocol

This outcome is designed to introduce learners to BIM and there is no requirement to undertake any of the stages discussed as part of the delivery. However, if the appropriate software is available, then 3D modelling and performance simulation would greatly aid the learning.

## Guidance for delivery

This unit requires access to both manual and computer based drawing equipment. There is an explicit need to produce drawings up to A2 size manually and A3 electronically, although the provision of a large format plotter would be beneficial. There is no need for a specific computer drawing application and there are many free CAD systems available as shareware and free ware and some companies offer free software to students.

It is envisaged that the manual drafting will be delivered first. Many may feel there is no need for this skill to be taught, however, it is a vital skill and learners must be able to convey technical information by hand. Many of the techniques and drawing conventions learned manually will be able to be transferred to the Cad system. By the end of the unit learners will be expected to produce industry standard plans elevations and sections suitable for planning and building regulation purposes. Both manual and computer based drawing will be required as part of the synoptic tests.

This is a practical module and the best way to teach and learn this subject is by sketching and drawing. Practical exercises in class will reinforce the skills required. This module can be used to reinforce construction technology knowledge as learners can draw all the component parts of a building.

UAN:	Y/506/5424
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is for learners to understand and evaluate the factors that affect the design and planning processes, the changes in style and attitude towards the built environment, the built environment's response to community need, social integration and the relationship between function, form and visual appearance. Opportunities are provided to discover the impact of historical, political, economic, social, infrastructure and aesthetical factors on design, to explore how the availability of private and public funding impacts upon design, to investigate how the cyclical nature of economic growth and recession affects design and to see how 'form follows function'. This approach will be supported by an understanding of how planning procedures affect design. Design and planning issues will be integrated by the production of supporting sketches and diagrams.

This unit explores the understanding and skills used to provide the technological design link between concept, innovation and reality. Learners will investigate how to work through the stages of the design cycle to arrive at a final design solution that meets with the approval of the planners. To do this they must know the important sources of design information and understand how to use plans of work in a structured way. The unit also offers learners an opportunity to demonstrate their understanding and skills by producing a final design solution and the completed documentation that must accompany a planning application.

The unit is of prime interest to learners contemplating a career in design and planning as architects, architectural technologists and town planners, but is of general interest to any learner studying the wider aspects of design and planning. No prior knowledge of design and planning is required but learners should possess basic numeracy and literacy skills in order to understand the content properly.

### Learning outcomes

In this unit, learners will be able to

1. understand the roles and responsibilities of the design team
2. recognise the factors that influence client requirements
3. understand the framework within which design and planning operates
4. produce a final design solution and associated planning documentation

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Understand the roles and responsibilities of the design team

### Topics

- 1.1 Roles and responsibilities
- 1.2 Factors that influence design
- 1.3 Technical information used in design

#### Topic 1.1

Learners must understand the roles, relationships and communication channels within the design and build team and the relationship that the team as a whole has with the client. A failure to develop a clear understanding of the hierarchical structure, customs, channels and methodologies for communications amongst the team members may lead to failures in design and/or build. This could have far-reaching consequences including abortive work that goes unpaid, unacceptable design that is not fit for purpose, unbuildable or unsafe designs, litigation and bankruptcy. The following must be considered.

- Communication within a design team and the roles of each party top the process (client, architect, architectural technologist, landscape architect, structural engineer, civil engineer, building services engineer)
- Communication within a production team (project manager, health and safety officer, quantity surveyor, site manager, site engineer, construction team)
- External advisors (design consultants, local authority)
- Legal implications of relationship between the client and the contract design team

#### Topic 1.2

Learners need to be aware that the successful design of any building or construction project is dependent upon a range of factors, many of which are in conflict. This results in the final design being a compromise, if the requirements of the differing factors are met to differing degrees. The factors that influence design are not necessarily of equal weight or equal value, and some are more subjective than others, but, nevertheless, they must all need be given consideration as part of a checklist for the design process as a whole.

The learner needs to give consideration to the factors below which influence design throughout the lifecycle of a building.

- Community needs and social impact
- Economic and financial issues
- Technical issues
- Aesthetics
- Infrastructure requirements
- Legal controls on design
- Environmental issues

#### Topic 1.3

Learners must evaluate the impact of regulation, technical detail and the 'buildability' of a proposed design by reference to the criteria below and any other criteria specific to particular proposals. They must understand how a design may be detailed and refined by, for example, using manufacturer's product data sheets to ensure compliance with regulatory instruments and/or bodies.

- Building Regulations and Approved Documents
- NHBC Standards (for new residential)
- Design data and solutions
- Construction Design Management Regulations
- Manufacturers' product information
- Environmental information
- Contractual arrangement

### Learning outcome:

#### 2. Recognise the factors that influence client requirements

##### Topics

- 2.1 Client requirements
- 2.2 Constraints on design
- 2.3 Environmental issues

##### Topic 2.1

Learners need to be aware that a client's requirements will be guided by many professionals such as architects and engineers to ensure that there is a clear understanding of which features of a design are desirable, compared to the extent to which they are achievable within budgetary and/or time constraints. It is often the case that a client requires maximum function/form for minimum financial outlay and the learners must become familiar with comparative methodologies, such as cost/benefit analyses, in order to arrive at the best compromise solution and thereby underpin and justify the choices made. The following must be considered.

- Function/form
- Aesthetics
- Spatial needs
- Budget/time constraints

##### Topic 2.2

Constraints tend to be limited only by the available technology and the proposed budget. The learners must understand that constraints tend to interact with each other and cannot be looked at in isolation. The constraints include the following.

- Design/Buildability
- Aesthetics
- Construction detailing
- Health and Safety plans
- Life cycle maintenance

- Cost/benefit analysis
- BATNEEC (Best Available Techniques Not Entailing Excessive Cost)

### Topic 2.3

Inevitably, development of any kind will have some impact on the environment. The learner must understand that while the impacts of some choices of the design will be fairly obvious, others may be less so. Learners need to be aware that there is no such thing as the perfect building material or the perfect design, because all development will impact on the environment in some way. It is through informed choice and design that the environmental impact may be minimised, although it cannot be removed altogether. The following must be considered.

- Impact of design
- Sustainable construction/design
- Flooding
- Serviceability
- Recycling

## Learning outcome:

### 3. Understand the framework within which design and planning operates

#### Topics

- 3.1 Developmental control
- 3.2 Statutory framework and planning application procedures
- 3.3 Environmental protection

### Topic 3.1

Learners should be aware of the principal constraints for development control i.e. planning legislation and Building Regulations and how they are both separate instruments, albeit inextricably linked with each other. Learners should be guided towards resources such as the Planning Portal, with tools such as the 'Interactive House', to develop a basic understanding of Permitted Development. This must be done in relation to the:

- Town and Country Planning Act
- General Permitted Development Order
- Building Regulations and Building Control

### Topic 3.2

Learners must develop an understanding of how the planning departments of local authorities arrive at planning policies and general development framework plans for their own particular geographic areas, and how lobbying by interested parties may influence their decisions regarding the following.

- Planning policy and applications
- General Development Framework Plans and Policy

### Topic 3.3

Learners must gain an understanding of the process whereby: buildings become listed; areas become designated as 'of outstanding beauty'; trees have preservation orders attached to them and so forth. The learner must develop an understanding of the criteria used and how these may be legally challenged. This must be done with reference to the following.

- Areas of outstanding beauty and national parks
- Trusts
- English Heritage and Listed Buildings
- Tree Preservation Orders

### Learning outcome:

#### 4. Produce a final design solution and associated planning documentation

### Topics

- 4.1 Design drawings and specifications
- 4.2 Planning documentation

### Topic 4.1

Learners must apply design principles to produce the drawings and specifications that comprise a realistic design solution to given briefs. They must manage the process as follows, assuming comments and recommendations made by planners after each stage.

- Initial design solution and material specification
- Alternative design solutions and material specifications
- Final design solution
- Consideration of 'buildability' at all stages

### Topic 4.2

Learners must understand the documentation that must accompany a planning application, and be able to complete the documentation required to support such an application. They must understand how to complete either

- a 'householder' planning application form for an extension, garage, outbuilding, loft extension or similar; or
- a 'new build' planning certificate, with relevant certificate of ownership as per Article 7 of the Town and Country Planning Act 1990.

### Guidance for delivery

Tutors have opportunities to use a wide range of techniques. These should include lectures, small and large group discussions, case studies, demonstrations, research using the internet and/or other library resources and presentations by guest speakers. Delivery should stimulate, motivate, educate and enthuse learners.

Centres would benefit from visits to building sites and heritage buildings. The use of case studies, DVDs, videos and photographic material will be useful as a secondary source of data. Whatever teaching, learning and assessment strategies are employed, health, safety and welfare issues must be paramount at all times. Risk assessments must be completed for all activities and should be strictly reinforced through close supervision in drawing offices, studios and classrooms. Design is not

generally considered a high risk activity for those who do it, but the designs they produce can have serious health, safety and welfare consequences for those charged with constructing the building, and for those managing and using the building after its construction. The ideal work environment for this unit would be a design or planning office, and any form of work-placement, work-experience or work-shadowing in such an environment would prove invaluable. If this is not available then presentations by design and/or planning professionals would be very useful. If neither is feasible the student's home is suggested as a convenient and accessible 'work-related environment'.

Learners contemplating a career in estimating, tendering or quantity surveying will need to develop an understanding of this unit as well as design-minded learners because of the importance of interpreting drawings in those careers.

UAN:	H/506/5426
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is for learners to recognise and understand the importance of property maintenance and property conversion in relation to the life cycle of buildings. Opportunities are provided for the learner to consider the wider effects of; poor quality construction and maintenance, understanding the impact on human life, the local area and the structure itself. Learners will be able to identify and give reasoning for different types of maintenance, refurbishment and adaption to buildings, demonstrating understanding where differing 'levels' of maintenance are best applied within the industry. This approach is to support learners ability to recognise poor quality construction, material selection, select suitable interventions and produce accompanying maintenance schedules. Learners will also interpret and analyse legislation and its impact on maintenance and conversion.

People use buildings every day. These buildings have one thing in common in that they all need to be maintained. Until such time as we can design and build truly maintenance-free buildings, there will always be a need for maintenance. In addition to requiring maintenance, the form of buildings will also change over time and buildings will often need to be converted to another purpose. Over the years, a whole sector of the construction and built environment sector has been developed that focuses solely on the maintenance and conversion of existing buildings. This accounts for approximately half of all construction work, and, when taken together, this comprises a multi-billion pound industry all on its own.

This unit will provide learners with an understanding of that market, and the nature of the work that goes on within it.

### Learning outcomes

In this unit, learners will be able to

1. recognise the characteristics of maintenance and conversion
2. understand the processes used to maintain the built environment
3. understand the processes used in the conversion of property



## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Recognise the characteristics of maintenance and conversion

### Topics

- 1.1 Property repair and maintenance
- 1.2 Property conversion and adaptation

#### Topic 1.1

Learners must understand the reasons why properties require repair and maintenance. They must understand that materials used in the construction of buildings will deteriorate over a period of time and they must know what the causes of deterioration are. They also need to understand that factors such as poor design and specification of materials, and poor quality construction, can exacerbate the need for maintenance and repairs. Similarly learners will need to understand how the use of the building, and the users of a building, can affect the property. Finally learners should be aware of issues such as mechanical failure, and that plant and equipment can reach the end of its useful serviceable life, and will therefore need regular maintenance to avoid the need for costly repair.

Areas to consider include the following.

- Climatic effects on the materials and structural stability of a property
- Impact of humans on the building (vandalism, wear and tear)
- Lack of maintenance
- Poor design and detailing
- Inappropriate material selection
- Impact of poor workmanship
- Mechanical failure and plant and equipment coming to the end of its useful life
- Change of property use (change of loads)
- Inappropriate previous interventions
- Structural failure
- Movement of the structure

#### Topic 1.2

Learners must understand the reasons why property is refurbished and adapted during their lifecycle. Property will be adapted or refurbished for a number of reasons and the level of intervention will depend on the reason for adaptation or refurbishment. Learners need to understand that projects range from small-scale alterations through to huge schemes that alter the size, shape and character of the building or even demolish parts of the existing structure and replace with new build.

- Reasons for refurbishment and adaptation
  - Building obsolescence (financial, technological, social)
  - Old and dilapidated properties (both residential and commercial)
  - Lack of land
  - Need to use more brownfield sites
  - Conservation of the historic environment
  - Societal changes
  - Changes in legislation
  - Individual needs
  - Fashion/desires

- Types of refurbishment and adaptation
  - Small scale works and minor repairs
  - Conservation of the historic environment
  - Changes to improve living standards
  - Updates to meet new legislative standards
  - Internal structural alterations
  - Extensions and additions
  - Façade retention
  - Demolition

### Learning outcome:

## 2. Understand the processes used to maintain the built environment

### Topics

- 2.1 Types of maintenance
- 2.2 Maintenance inspections
- 2.3 Scale of maintenance and repair work required

#### Topic 2.1

Learners require an appreciation of the different types and levels of maintenance. Learners must be aware that planned and preventative maintenance is always preferable and that emergency maintenance is not ideal. They must recognise that, through good property management, this can be avoided. Learners need to be able to describe each of the maintenance levels and relate this to the various elements of a property. This will include the following.

- Preventative maintenance
- Planned maintenance
- Programmed maintenance
- Emergency maintenance

#### Topic 2.2

Learners must describe the elements of a building that need to be inspected, and with what regularity. For each element a learner will need to be able to describe the construction methods and materials of the element and identify typical defects associated with it. They should be able to identify obvious examples of poor quality construction and selection of materials, and suggest suitable interventions to rectify the problem. Learners are required to be able to produce a schedule of maintenance following an inspection of a property. This should include both immediate and long-term maintenance items, intended to increase the useful life of a building. Elements of a property to consider include the following.

- Roof
- Chimneys
- Walls (internal and external)
- Doors and windows
- Stairs
- Floors (internal and external)
- Services (electric, gas and water, drainage, emphasis must be given to the need for gas safe and registered electricians for this work)
- Health and safety issues for building users

### Topic 2.3:

Learners must differentiate between the levels of repairing intervention and when it is most appropriate to select the different methods. There is no need to undertake repairs, but they do need to be able to identify the defect, analyse the severity of the problem and describe a suitable level of intervention to rectify the defect. The following should be considered.

- Scale of repairs
- Temporary/emergency repairs
- Repair of immediate problem but no other works
- Removal of defective material/item and associated repairs
- Renewal/replacement with new materials replacing the entire defect and associated repairs.

### Learning outcome:

#### 3. Understand the processes used in the conversion of property

### Topics

- 3.1 Conversion and adaptation processes
- 3.2 Legislative requirements for conversion and adaptation
- 3.3 Preparing documentation to support conversion and adaptation

#### Topic 3.1

Learners need to be able to describe the reasons why a property would be refurbished and the stages of the conversion process that would have to be undertaken. They need to understand the different stages, the people involved, and the links between each stage. This should all be considered under the following headings.

- Identification of need (see above)
- Property inspection
- Feasibility
- Initial design
- Detailed/final design
- Tender process
- Construction
- Building use (maintenance issues)

#### Topic 3.2

Learners must be able to analyse a conversion project and establish what aspects of legislation are applicable. The size, scale, location and reason for conversion will have an impact and learners must be able to interpret the brief, analyse the property and its location, and apply the relevant legislation. The following must be taken into account.

- Town and Country Planning
- Listed Building Consent
- Conservation Area Consent
- Areas of Outstanding Natural Beauty
- Sites of Special Scientific Interest (SSSI)
- Building Regulations
- Fire Risk Assessments (commercial properties)
- CDM
- Health and Safety

- Party Wall Act
- Right to Light
- Tree Preservation Orders

### Topic 3.3

Learners will apply previous learning to the process of preparing a scheme for property conversion and adaptation.

Learners will follow the processes listed in 3.1 and consider the requirements of 3.2. Learners will be able to do the following.

- Inspect a property to ascertain current condition and feasibility for conversion
- Measure the property to produce drawings
- Produce sketch schemes for clients approval
- Produce detailed schemes for conversion and adaptation to meet the clients brief and be compliant to the relevant legislation
- Communicate the scheme through drawings (plans, elevations and sections both sketch schemes and scale drawings) and schedules of work and specifications.

## Guidance for delivery

This unit should be delivered in a practical manner. It is recommended that existing buildings known to the learners are used, for example the school or college buildings. Learners should be encouraged to inspect buildings and analyse defects and ascertain the need for maintenance. The centre where the subject is being delivered will have significant maintenance needs and the facilities manager would be used to reinforce delivery. Similarly visits to hospitals, or shopping centres will allow learners to see first-hand the scale of maintenance. The local authority housing team and housing associations will also potentially provide a good range of properties all with differing maintenance needs. Property managers and maintenance managers would be ideally placed to deliver guest lessons and forging links with appropriate people should be encouraged. On a point of health and safety there is no need for any learner to undertake any works at high level or below ground.

For the conversion section of the module, again learners should be encouraged to learn through experience. The use of local buildings that have been converted is actively encouraged. Visits to sites that are currently undergoing conversion will illuminate the subject and should be incorporated into the delivery as often as possible. Projects of any scale and size will be suitable as it will allow learners to grasp the scale and size of different projects. When applying their knowledge, learners can use their own classroom or parts of the centre, or even their own home. Converting the classroom into a one bedroom flat is often a popular activity, allow the learners access to design and anthropometric data to ensure accuracy of their proposal. Consideration should be given to health and safety at all stages of the project.

UAN:	L/506/5436
Level:	3
GLH:	60

### What is this unit about?

The general perception of a building surveyor is of a person who surveys houses to determine their structural stability, or values properties for the purpose of purchase. In reality, the role of the modern building surveyor is much wider-ranging, and overlaps with many aspects of other professional roles within construction. Building surveyors are a relatively recent addition to the professional ranks in the built environment sector and one that requires flexibility and a wide range of skills.

It would not be unusual for a building surveyor to undertake a survey for a mortgage lender in the morning, and then visit a construction site in the afternoon in the role of a contract administrator, designer or CDM Coordinator. They could be involved in legal work such as party wall disputes, or as an expert witness, or providing advice on how a client can improve the sustainability of their property. Building surveyors work in both the residential and the commercial sector and although they are generally involved in refurbishments and adaptations, they can also work on new build schemes too.

A building surveyor needs to be technically proficient in both old and new methods of construction and must have a good understanding of many legal issues. This unit focuses on the role of the building surveyor and provides the learner with a broad understanding of the types of work undertaken by a typical building surveying practice. Learners will have the opportunity to develop the skills required to undertake different types of survey. Learners will be able to describe a number of different survey types and then undertake a building and measured survey producing the subsequent reports and drawings using the appropriate tools and equipment.

On completion of the module the learner will be proficient to undertake a survey and produce a report. There is no requirement for learners to undertake any destructive forms of surveying work at height work underground and test any service provision. The tutor delivering this module should be an experienced industry professional with a good working knowledge of construction, construction techniques and defects. Health and safety is of paramount importance and must be considered at all stages and not just in learning outcome.

### Learning outcomes

In this unit, learners will be able to

1. understand the role of the building surveyor
2. determine the different types of survey undertaken by a building surveyor
3. undertake different types of building survey

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved. Reference to health and safety legislation, and appropriate standards (British Standards and the International Organisation for Standards), should be made whenever appropriate throughout delivery of the unit, but there is no requirement for a detailed understanding of any of the legislation, regulations or standards at this stage.

### Learning outcome:

#### 1. Understand the role of the building surveyor

### Topics

- 1.1 Role of the building surveyor
- 1.2 Becoming a building surveyor

#### Topic 1.1

The role of the building surveyor is diverse and wide ranging and learners need an understanding of the wide ranging nature of the role. Surveyors may specialise within one field but many surveyors in private practice will undertake a wide variety of projects. Learners should be aware of the types of work a building surveyor will undertake and the fields in which they operate. These include:

- Residential
  - Surveys (various types depending on the circumstances)
  - Maintenance works
  - Design, specification and management of refurbishment, adaptation or extension works
  - Legal matters such as party wall, rights to light, boundary disputes, expert witness
  - Planning and Building Regulation advice
- Commercial
  - Surveys (various types depending on the circumstances)
  - Maintenance works
  - Design, specification and management of refurbishment, adaptation or extension works
  - Legal matters such as party wall, rights to light, boundary disputes, expert witness, Landlord and Tenant (Dilapidations and Schedules of Condition), Health and Safety Audits, Fire Risk Assessments, Equality Act Audits (DDA) CDM designer and CDMC roles
  - Planning and Building Regulation advice
  - Space utilisation audits and spatial planning
  - Project management

Building surveyors work in a variety of companies and sectors and learners require an understanding of the different sectors and roles within each of those sectors. These will include the following.

- Commercial surveying (private practice)
- Local authority
- Development companies
- Housing associations
- Organisations with a property portfolio such as the church, pension funds, military etc.
- Construction contractors
- NHS Trusts

Learners do not need a detailed analysis of each sector, however, they do need to be able to differentiate between the works undertaken in each and be aware of the role of the building surveyor who works 'on the client side' or otherwise.

### Topic 1.2

There are a number of ways an individual can become a building surveyor and learners need to be aware of the options available and the different entry routes. They must be aware that to be able to use the designation of 'Chartered Building Surveyor' they must undertake the training and qualifications as stipulated by the RICS. Learners should be able to describe the routes and requirements including:

- General education and experience to allow entry
- RICS Assessment of Professional Competence (APC) and levels of membership (MRICS, AssocRICS)
- Chartered Institute of Building (CIOB) alternative

Learners should be aware of the training requirements of the APC and the core competencies, but they do not need a detailed knowledge of each aspect.

## Learning outcome:

### 2. Determine the different types of survey undertaken by a building surveyor

#### Topics

- 2.1 Types of survey
- 2.2 Tools and equipment used in building surveys
- 2.3 Health and safety considerations when performing building surveys

#### Topic 2.1

Learners must be aware of the wide range of surveys a building surveyor will be expected to undertake. They should be able to describe these survey methods, including the purpose of the survey, and how, when and why it may be carried out. They are not expected to be able to undertake these surveys (with the exception of a building survey and measured survey), but they should be able to differentiate between them and select the correct survey for different scenarios. For example a learner should be able to state that at the end of a commercial lease term a dilapidations survey would be the most appropriate survey for the landlord. Or that a schedule of condition should be prepared in party wall matters. The surveys to consider are as follows.

- Building survey
- Measured survey (dimensional survey)
- RICS (Level 1, Level 2, Level 3)
- Mortgage valuation
- Schedule of Dilapidations
- Schedule of condition
- Stock condition survey
- Insurance reinstatement survey
- Defect analysis survey

#### Topic 2.2

Each of the surveys considered in 2.1 above will require a range of tools and equipment. Some of these will be standard items such as a hammer or a screwdriver, or they could be specialist equipment such as a speedy moisture testing kit or a thermal imaging camera. Building surveyors will tend to carry a standard tool kit to each survey and hire-in specialist items when

needed due to prohibitive costs. Learners should be able to state the tools and equipment that are typically required when undertaking the surveys listed above, and understand when each is used and what they are used for. The tools may include the following.

- Dictaphone
- Camera
- Clip Board, note pad and pencil
- Moisture Meter
- Tape measure this would be either a manual tape (both 5m steel and 30m plastic) or a hand-held laser measure
- Compass
- Endoscope
- Cordless drill plus some form of plug to seal the hole to prevent ingress of insects or moisture etc.
- Floor board saw
- Claw hammer
- Bolster
- Cold chisel
- Spade
- Drain plugs
- Coloured dyes
- Angle measure
- Calibrated tell tales
- Respiratory mask
- Gloves
- Barrier cream
- Hand sanitiser
- Wellington boots
- Drain keys
- Pen knife
- Screwdriver
- Torch
- Carbide moisture test kit for
- Metal detector
- Stud detector
- Folding or collapsible surveyors ladder.
- Binoculars
- Spirit Levels, both long and short
- Folding wooden (plastic) rule

### **Topic 2.3**

Like all construction operations, building surveying has inherent occupational dangers and learners need to be aware of the hazards encountered when working as a building surveyor. They do not need an in-depth knowledge of all aspects of legislation, but they must be aware of the hazards, how to reduce the risks and undertake the role of the surveyor safely. Typical hazards for consideration are:

- working at height



- working in confined spaces
- lone working
- contact with deleterious materials
- structural stability of the property
- occupants (humans and animals)
- services
- hidden ducts, voids or holes
- unsafe atmospheres

Before undertaking a survey the surveyor must be satisfied with all health and safety issues and learners should be aware of the duties of employers and employees under the Health and Safety at Work Act 1974, and the implications for the surveyor. Learners should also be familiar with risk assessments and how to undertake a dynamic risk assessment for differing site conditions. Before undertaking any survey learners must be able to list the hazards, risks and control measures they will put in place to ensure their safety.

### Learning outcome:

### 3. Undertake different types of building survey

#### Topics

- 3.1 Preparing to undertake surveys
- 3.2 Undertaking a building survey
- 3.3 Undertaking a measured survey

#### Topic 3.1

Prior to undertaking any survey there are procedures for the surveyor to follow. It is not simply a case of turning up on site and looking at a building. A good surveyor will have a standard operating procedure and follow this for every survey. Learners should be aware of the types of information the surveyor will gather prior to visiting site, why they are important and where the information can be obtained.

This will include the following.

- Confirmation of client instructions
- Health and safety issues
- Access arrangements
- Legal matters
- Information and documents relevant to the property (e.g. copies of planning documents or schedules of condition etc.)

#### Topic 3.2

This is a practical outcome and learners will undertake surveys of different properties and elements of properties. Learners need to understand what a building survey is, how to undertake one, what to survey, how to record the information, and how to present the information. On completion of topic 3.2 learners will be able to undertake a survey of a typical domestic scale property and produce a professionally presented building survey.

The building survey is to be considered a record of the condition of a property. This will include details of the construction method of the property and a record of any defects evident at the time of inspection. The term building survey will be used throughout, to avoid confusion with a schedule of condition, as this type of survey follows a specific format.

A survey is simply a snapshot of a property (or parts of a property) at a given time. Learners must be given time to take their own snapshots to allow them to learn to identify, diagnose and report on defects. There is no requirement at this stage for learners to be able to suggest repair or maintenance options for the defects but they do need to understand the potential implications of the defects and the potential long term impact on the property. Learners will need to understand what they will need to inspect on site. This will include the following.

- Roofs
- Rainwater goods
- External walls
- Doors and windows
- Internal walls
- Internal floors
- Stairs
- Adjacent land, properties, garages and boundary walls
- Services

Health and safety should be reinforced throughout delivery and the hazards specific to each element must be discussed. There is no need for learners to work at height or to come into contact with live services. They should be able to state what an experienced surveyor will do when inspecting these elements.

For each of the elements learners should be able to identify the following.

- The materials and methods of construction
- The defects of each element

For example, a learner should know that cracks to masonry could be caused by thermal expansion, substructure failure, changes in loading, poor construction methods or failure of specific elements such as lintels etc. They do not need a detailed scientific understanding of the problems, but they must be able to identify a defect and consider what could have caused it.

Whilst undertaking the survey learners should be taught to record their field notes in a structured and methodical manner, listing all the defects they have identified. This will then aid production of the report. Learners should be shown different ways to present their survey notes and produce reports in different formats such as tabulated and descriptive methods. They must also incorporate photographs and sketches/drawings into their reports. Learners should be able to take instructions, confirm the requirements, prepare for, undertake and produce a survey report for a typical residential scale property.

### **Topic 3.3**

A measured or dimensional survey is a detailed inspection which records the physical size and characteristics of a property. Learners will be taught how to measure a property and produce plans, elevations and sections. By the end of this topic learners will be able to measure a domestic scale property and produce accurate scale plans.

Learners will need to learn how to:

- prepare for a measured survey
- use tapes and other measuring devices such as laser measures
- produce accurate sketches
- measure and record information accurately
- transpose field notes into accurate scale drawings.

## Guidance for delivery

Building surveying is a practical job and delivery should be focused on making the unit as practical and hands-on as possible. The learners must be able to undertake two different types of survey and it will be beneficial for them to inspect properties throughout the module. Centres can utilise local Chartered Building Surveyors for guest lectures and where appropriate site visits with experienced surveyors. Due to the complexity and technical knowledge this module should be delivered by an experienced surveyor preferably one with recent industrial experience. Learners should be given the opportunity to undertake a wide range of typical building surveying jobs such as surveying, design and specification. In addition to this learners should be encouraged to utilise a range of communication methods to provide them with a better understanding of the role of the building surveyor.

Delivery should be a mixture of class-based knowledge sessions followed by the practical application of this knowledge. Learners should be encouraged to work individually and in groups to provide a better understanding of the role. Formative self-assessment would work very well within this module with learners encouraged to swap survey notes to produce reports and drawings. There is no need for any specialist equipment but learners will need access to tape measures and drawing equipment. Damp meters and laser-measuring devices would be beneficial, but not essential.

Learners will be required to produce a survey report and drawings to satisfy the requirements of LO3, this requirement links to the maintenance module and centres are encouraged to create realistic scenarios for learners, and cross-over here is actively encouraged.

Building surveying, like any other construction role, has inherent health and safety considerations. There is no need for learners to work at height, in holes or underground and with live services. Centres must actively manage this and ensure the safety of their learners. Roofs can be inspected from ground level with binoculars, services should not be touched by anyone unless specifically qualified to do so.

UAN:	F/506/5448
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is to make learners aware of the development of building standards within the United Kingdom. The development of building standards has been driven by many things over many years, including serious building failures, poor living conditions, disease and fire. Nowadays we must also consider the urgent need to reduce the amount of energy consumed by homeowners and businesses.

The Building Regulations set out the minimum standards that are required for new builds and adaptations. The regulations ensure that buildings are structurally sound, and contribute to the creation of a safe, healthy and comfortable environment for the occupant(s).

Learners will investigate the different regulations that been developed to address the above challenges, and will explore current practice in terms of how the Building Regulations apply to today's buildings. Learners will examine, interpret and use the standard documentation that must be completed to gain building control approval, and will investigate the different enforcement bodies involved in building control.

Learners will be given opportunities to access current Approved Documents in order to relate the standards to modern building methods.

### Learning outcomes

In this unit, learners will be able to

1. understand the history and purpose of the Building Regulations
2. recognise how the Building Regulations apply in practice
3. complete documentation associated with Building Regulations procedures

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Understand the history and purpose of the Building Regulations

##### Topics

- 1.1 Historical factors
- 1.2 Purpose
- 1.3 Current practice

##### Topic 1.1

Learners must understand that building standards have improved over time as a result of a growing population and the industrialisation of the country. They must understand the following factors that have driven these changes.

- The Great Fire of London 1666
- Development of local by-laws
- The Industrial Revolution
- Poor living and working conditions in Victorian Britain
- Poor hygiene and spread of disease
- Post-World War II reconstruction and the need for cheap and speedy construction methods.

##### Topic 1.2

Learners must understand that the purpose of the Building Regulations is to lay down minimum standards in order to create a safer and healthier built environment for the general public. Learners must understand the importance and purposes of the following pieces of legislation.

- London Building Act 1667
- Public Health Act 1875 (and subsequent revisions)
- The Planning Acts of 1934 and 1936
- The Building Regulations 1965
- The Building Act 1984
- The Building Regulations 2000 (and subsequent revisions)

##### Topic 1.3

Learners must understand how development of the Building Regulations has led to improved building standards through the following concerns and practices.

- Conservation of fuel and energy
- Measures to combat climate change (including Kyoto treaty and increased global awareness)
- Code for Sustainable Homes
- Introduction of Standard Assessment Procedure (SAP) ratings.
- Waste management plans
- Water management systems

### Learning outcome:

#### 2. Recognise how the Building Regulations apply in practice

## Topics

- 2.1 Application of Approved Documents to new build
- 2.2 Application of Approved Documents to alternations/renovations

### Topic 2.1

Learners must understand how Approved Documents are used in the design and construction of domestic and commercial new builds for the following components/purposes:

- foundations
- walls
- floors
- insulation
- stairs
- ventilation
- light
- hygiene
- fire
- access

### Topic 2.2

Learners must understand how Approved Documents are used in the design, conversion and adaptation of existing commercial and domestic dwellings including:

- Homes in Multiple Occupancy (HMOs)
- fire
- sound
- insulation
- access.

## Learning outcome:

### 3. Complete documentation associated with Building Regulations procedures

## Topics

- 3.1 Approval procedures
- 3.2 Enforcement procedures

### Topic 3.1

Learners must complete the documentation associated with both 'full plan' and 'building notice' approval procedures in terms of

- information required
- application process
- cost
- timescale
- special constraints
- advantages and disadvantages of each procedure.

### Topic 3.2

Learners must complete the documentation associated with the role of both Local Authority Building Control Officers and Approved Inspectors in enforcing the Building Regulations, in terms of

- number of visits
- schedule of visits
- communications
- remedial action(s) to be undertaken to satisfy inspector
- role of approved inspector
- role of the NHBC
- benefits of approved inspection.

## Guidance for delivery

Tutors have opportunities to use a wide range of techniques. These should include lectures, small and large group discussions, case studies, demonstrations, research using the internet and/or other library resources and presentations by guest speakers. Delivery should stimulate, motivate and educate learners.

Centres would benefit from visits to building sites where possible. The use of case studies, DVDs, videos and photographic material will be useful as a secondary source of data.

Teaching and learning strategies should take an integrated approach and must combine learner-centred investigative techniques with supervised, hands-on, experiential learning that involves working from original documentation, making observations, consulting reference documents and forming conclusions.

UAN:	A/506/5450
Level:	3
GLH:	60

### What is this unit about?

Changes in the environment, resulting from natural phenomena, are a continuing challenge to us all, and especially to the construction and built environment sector. There are many new sustainability initiatives and improved technologies intended to reduce our carbon input to the environment. This unit will look at the ways we can reduce our carbon footprint by looking at renewable energy, the ways in which we can reduce pollution and waste, and the implications of all this for new methods of construction. A failure to address these issues will almost certainly lead to an increase in the unpredictable weather patterns we have seen across the globe in recent years.

### Learning outcomes

In this unit, learners will be able to

1. understand renewable energy technology
2. understand pollution control
3. understand waste management
4. understand sustainable construction techniques



## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Understand renewable energy technology

##### Topics

- 1.1 New technologies for renewable energy
- 1.2 Benefits of renewable energy and efficient technology

##### Topic 1.1

Learners must understand the different types of new technologies available.

- Ground source heat pumps
- Air source heat pumps
- Hydro electricity
- Solar PV
- Solar water
- Geothermal
- Biomass (wood, crops)
- Wind turbines
- Tidal

##### Topic 1.2

Learners must be able to explain the benefits of new technologies, both by retro-fitting and by use in new build, and they must be able to evaluate the efficiencies each will bring.

- Renewable source of energy
- Reduced emissions (carbon and others)
- Financial incentives
- Reduced environmental impact (carbon neutrality)

### Learning outcome:

#### 2. Understand pollution control

##### Topics

- 2.1 Impact of global pollution
- 2.2 Pollution generated by non-renewable sources

##### Topic 2.1

Learners should understand how global and local pollution impacts on humans and the environment in each of the following ways.

- Air
  - CO<sub>2</sub>
  - Acid rain
  - CFCs
  - Smoke
  - Photochemical smog
  - Indoor air quality (Sick Building Syndrome)

- Water
  - Over-extraction
  - Pollution by communities, industry, agriculture
  - Eutrophication
- Land
  - Contamination by communities, industry, agriculture
  - Remediation techniques
  - Over-development
  - Destruction of habitat and biodiversity

### Topic 2.2

Learners should understand how pollution is generated by non-renewable sources such as the following.

- Fossil fuels
- Nuclear fuel
- Fracking

## Learning outcome:

### 3. Understand waste management

#### Topics

- 3.1 Waste management techniques
- 3.2 Legal implications
- 3.3 Financial implications

#### Topic 3.1

Learners must understand the different types of waste generated on a construction site, how waste is categorised, where the waste is produced and how to manage its disposal. Learners must understand the importance of waste audits and how they are carried out.

Waste materials will include the following.

- Timber
- Plastic
- Paper
- Stone/concrete/clay
- Metals
- Gypsum
- Chemicals (paints, adhesives, solvents, gases)
- Architectural salvage
- Glass

#### Topic 3.2

Learners will need to evaluate the impact of ineffective working methods of waste control. Learners will evaluate construction materials and products to minimise the waste potential.

- Regulations
- Volatile organic compounds
- SWMPs
- Storage, transportation and disposal

### Topic 3.3

Learners must explain financial impact of disposing materials locally and segregating materials.

- Landfill tax
- Cost of disposal
- Penalties

## Learning outcome:

### 4. Understand sustainable construction techniques

#### Topics

- 4.1 Embodied energy
- 4.2 Reducing energy consumption
- 4.3 Sustainable construction methods

#### Topic 4.1

Learners must understand embodied (embedded) energy and how this is dependent upon the energy dissipated in the location, extraction, manufacture and transport of materials such as the following.

- Types of glass
- Timber
- Insulation materials (rigid/flexible, natural/synthetic)
- Plastic goods
- Cladding
- Concrete (cement, aggregates)
- Metals
- Gypsum and limes
- Bitumens
- Composite materials

#### Topic 4.2

Learners must understand how the appropriate specification of materials in the construction process can improve human comfort in buildings. Examples should include the following.

- Reduction of heat losses
- Reduction of energy consumption
- Improvement of air quality

#### Topic 4.3

Learners must understand the different construction techniques currently used to increase efficiency in terms of reducing heat loss. Learners must compare:

- traditional and modern methods
- masonry v framed structures (concrete, timber, steel)
- forms of external enclosure (e.g. brick, composites, metal, plastic, glass).

## Guidance for delivery

Tutors have opportunities to use a wide range of techniques. These should include lectures, small and large group discussions, case studies, demonstrations, supervised laboratory practical work, research using the internet and/or other library resources and presentations by guest speakers. Delivery should stimulate, motivate, educate and enthuse learners.

Centres would benefit from visits to building sites, power & nuclear stations and materials testing centres. The use of case studies, DVDs, videos and photographic material will be useful as a secondary source of data, should first-hand experience of testing procedures prove difficult.

Teaching and learning strategies should take an integrated approach and must combine learner-centred investigative techniques with supervised, hands-on, experiential learning that involves, making observations, consulting reference documents and forming conclusions. Group activities are permissible, and indeed encouraged, but tutors must ensure that learners are able to provide individual evidence of understanding.

UAN:	J/506/5452
Level:	3
GLH:	60

### What is this unit about?

This unit will be valuable to learners with an interest in the property management sector. The learners will investigate the importance of property legislation, the economics of the property market, the methods used to make valuations of properties, the factors that affect property values, the acquisition and disposal of properties and the importance of facilities management.

Learners will explore the reasons for valuing a property, and will learn that the value of a property depends largely on what the prospective owner wants it for and what they intend to do with it. They will develop an understanding of the impact of mortgage and interest rates on funding, of the essential conditions and requirements for a mortgage, and will learn to perform simple calculations to determine mortgage repayments and how these can change with fluctuating interest rates.

The unit explores the most common method of valuing domestic property, involving comparison with similar properties for sale or rent in comparable or nearby areas, and examines the factors that affect such valuations. Learners will have the opportunity to investigate the procedures associated with the acquisition and disposal of properties (buying and selling) and will explore the importance attached to facilities management techniques and how these can enhance the use and value of a property.

### Learning outcomes

In this unit, learners will be able to

1. understand legislation associated with property management
2. identify the factors that affect the value of property
3. complete documentation associated with acquisition and disposal procedures
4. understand the principles of facilities management

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Understand legislation associated with property management

##### Topics

- 1.1 Property legislation
- 1.2 Terminology

##### Topic 1.1:

Learners must understand the relevance of each of the following pieces of legislation, and how each is used in the modern property market.

- Law of Property Act 1925
- Land Registry Act 2002
- Countryside and Rights of Way Act 2000
- Town and Country Planning Act 1990
- Landlord and Tenant Act 1954

##### Topic 1.2:

Learners must understand the terms used in property management and the nature of the work done.

- Freehold
- Leasehold
- Conveyancing
- Her Majesty's Land Registry

### Learning outcome:

#### 2. Identify the factors that affect the value of property

##### Topics

- 2.1 Economics of the property market
- 2.2 Methods used to value property

##### Topic 2.1

Learners must understand the economics of the property market in terms of

- the use of property as an investment
- sources of finance (banks, building societies and private finance)
- supply and demand
- elasticity in the market
- purchase v rent
- government intervention (e.g. Help to Buy Scheme)
- social issues
- land banks
- inflation/deflation (boom and bust) in the construction industry
- state of the economy (interest rates, bank rate, mortgage, rate of depreciation, inflation)

### Topic 2.2

Learners must understand the reasons for valuing property and the methods used as follows:

- **Reasons for valuing property:** to determine price for sale, for tax and insurance purposes, to determine outgoings and service charges, for council tax purposes, to obtain additional funding, for borrowing against equity (positive and negative)
- **Methods used:** valuation survey by competent person, comparison with similar local properties in same condition, valuation tables and associated formulae (amount of £1, present value of £1, amount of £1 per annum, sinking funds)

### Learning outcome:

#### 3. Complete documentation associated with acquisition and disposal procedures

### Topics

3.1 Terminology and definitions

3.2 Procedures

### Topic 3.1

Learners must understand the following terms, definitions and conditions as they apply to buying and selling property.

- Conveyancing procedures: searches, procurement (open offers, best and final bids, sealed bids, auction)
- Contract for purchase: details, conditions (standard, expressed and implied), capacity, consideration, legality, limits, remedies for breaches

### Topic 3.2

Learners must understand the contractual procedures associated with buying and selling property including:

- Law society protocols and processes, Transaction forms, exchange of contracts, deposits, formal signing of contract
- Searches: local authority, preliminary enquiries of vendor, HMLR, energy performance certificates.

### Learning outcome:

#### 4. Understand the principles of facilities management

### Topics

4.1 Facilities management procedures

4.2 Enhancing the efficiency and lifespan of property using facilities management

### Topic 4.1

Learners must understand how facilities management services are contracted and delivered in terms of

- in-house departments, responsible for all aspects associated with building maintenance, non-core business services and security
- facilities managers/management team overseeing a range of bought-in specialist contractors

- large multi-service companies providing full range of facilities management services.

### **Topic 4.2**

Learners must understand the contribution made by facilities management and support services, the type of work undertaken in facilities management and how facilities management has developed over time. This will include investigation of:

- the contribution made to: maintenance of the built environment, development of the built environment, economic and financial benefits, wealth creation, quality of life
- the difference between: hard facilities management (maintenance of built fabric and building services) and soft facilities management (catering, cleaning, health, safety and welfare, security, communications)
- recent developments: reduction in number of expensive emergency call-outs, on-going maintenance (building does not reach a costly state of disrepair), client can choose most cost-effective service providers for soft facilities management.

### **Guidance for delivery**

Tutors have opportunities to use a wide range of techniques. These should include lectures, small and large group discussions, case studies, demonstrations, research using the internet and/or other library resources and presentations by guest speakers. Delivery should stimulate, motivate and educate learners.

Centres would benefit from visits to building sites where possible. The use of case studies, DVDs, videos and photographic material will be useful as a secondary source of data.

Teaching and learning strategies should take an integrated approach and must combine learner-centred investigative techniques with supervised, hands-on, experiential learning that involves working from original documentation, making observations, consulting reference documents and forming conclusions.



UAN:	L/506/5453
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is for learners to use formulae and apply mathematical techniques in algebra, geometry, mensuration and statistics for solving a range of practical problems in construction. Technicians, working in the field of construction and civil engineering, will apply mathematics to do their job successfully regardless of their particular area of expertise.

The teaching/learning of this unit starts with the use of a scientific calculator and other basic techniques such as rounding and estimation. These are followed by the transposition and evaluation of formulae. The use of these techniques is not limited to mathematics for its own sake and the content is used in other units such as Science and Materials, Structural Mechanics, Site Surveying and Measurement, Tendering and Estimating. For instance, learning the solution of linear and quadratic equations is not just academic - both are used in several practical applications in construction and civil engineering.

In construction projects it is necessary to calculate areas and volumes. These include the area of land, volume of earthworks and area/volume of building finishes/materials. Their quantities have to be determined accurately using established techniques, because the cost of the project is dependent on these calculations. We will encounter both regular and irregular surfaces and components and this unit deals with the basic techniques of finding areas/volumes for both.

The land acquired for construction work has to be levelled before the setting out can commence. Setting out involves the measurement of angles and distances, and the use of formulae involving the trigonometrical ratios, so that the relevant calculations can be performed. Although many of these tasks are done by modern surveying instruments, learners need to understand the basics of the trigonometry used.

Many publications have statistical information on issues such as waste and recycling, road traffic accidents and falls from heights that are of interest to learners as well as engineers in the construction industry. Learners need the basic skills in statistics to understand and evaluate the published information. Learners also need to collect, analyse, present and interpret data. The topics included in this unit will enable learners to undertake these activities.

### Learning outcomes

In this unit, learners will be able to

1. use basic mathematics, methods and techniques to solve equations
2. use geometric and trigonometric techniques

3. use techniques to calculate perimeters, areas and volumes
4. use graphical and statistical techniques

## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

## Learning outcome:

### 1. Use basic mathematics, methods and techniques to solve equations

## Topics

- 1.1 Use of scientific calculator, rounding and approximation techniques
- 1.2 Indices and transposition
- 1.3 Linear and quadratic equations

### Topic 1.1

Learners must be able to recognise the function of the keys of a scientific calculator. They must be able to use the main keys for performing a range of calculations. They should be able to present the answer to a given accuracy and be able to use estimation for checking their answers. They must understand how this relates to the following.

- Add, subtract, divide, multiply; exponents, logarithms; sin, cos, tan; arc sin, arc cos, arc tan; degrees, radians
- Decimal places and significant figures
- Standard form
- Estimation of an answer

### Topic 1.2

Learners must understand the addition, subtraction, division and multiplication of algebraic expressions, and the laws of indices. They must be able to manipulate a range of formulae to change the subject of the formulae.

- Add, subtract, multiply and divide simple algebraic expressions
- Laws of indices
- Transposition of formulae (including formulae that involve squares, square roots, cubes and cube roots)
- Evaluation of formulae

### Topic 1.3

Learners must be able to differentiate between linear and quadratic equations. They should recognise that the number of roots of an equation depend on the power of the unknown. They must be able to use a range of methods for solving linear, linear simultaneous and quadratic equations.

- Linear equations
- Linear simultaneous equations (solution by substitution and elimination methods)
- Quadratic equations (solution by factorization and simultaneous formula techniques)

- Checking answers by re-substitution

### Learning outcome:

## 2. Use geometric and trigonometric techniques

### Topics

- 2.1 Geometric techniques
- 2.2 Basic trigonometric techniques
- 2.3 Sine rule and cosine rule

#### Topic 2.1

Learners must recognise different types of angles made by intersecting lines and geometric shapes. They must understand the concept of similar triangles, recognise different types of triangles and be able to apply Pythagoras' theorem to right-angled triangles. They must understand the properties of quadrilaterals and circles and apply them to solve practical problems involving the following.

- Properties of angles, units of measurement (degrees and radians)
- Properties of triangles
- Pythagoras' theorem and its application
- Properties of rectangles, trapeziums, parallelograms
- Properties of the circle and their practical application.

#### Topic 2.2

Learners must understand the trigonometrical ratios of sine, cosine and tangent, as applied to a right-angled triangle. They must be able to identify the hypotenuse, adjacent and opposite sides of a right-angled triangle. They must be able to determine the angle from the given trigonometrical ratio and vice-versa. They should be able to differentiate between the angles of elevation and depression and apply all these concepts to solve practical construction problems.

- Trigonometrical ratios (sine, cosine and tangent)
- Angles of elevation and depression
- Calculations involving angles in degrees/radians
- 2D/3D problems in construction.

#### Topic 2.3

Learners must understand that the trigonometrical ratios can only be applied to right-angled triangles, and that for determining the angles and sides of other triangles, different techniques need to be used. For a given triangle, they should be able to identify which rule to use and be able to recognise the ambiguous case.

- The sine rule
- The cosine rule
- Ambiguous case of the sine rule

- Area of a triangle (two sides and the enclosed angle known).

### Learning outcome:

### 3. Use techniques to calculate perimeters, areas and volumes

#### Topics

- 3.1 Perimeters and areas of regular shapes
- 3.2 Areas of irregular shapes
- 3.3 Volumes of regular and irregular objects

#### Topic 3.1

Learners must be able to calculate the perimeter of regular shapes. They should be able to identify triangles, quadrilaterals (rectangles, trapeziums, parallelograms) and circles, and be able to calculate their areas. They should understand the techniques used for calculating the surface area of regular objects, and identify the right units for perimeters and areas.

- Perimeters of regular shapes
- Area of triangles and quadrilaterals
- Area of circles, segments and sectors
- Surface area of regular objects (cylinders, spheres, pyramids and cones)
- Application of the above to construction problems

#### Topic 3.2

Learners must be aware that numerical integration methods can be used to calculate the area of irregular shapes such as building plots. They should be able to divide the irregular shape into appropriate number of strips and calculate its area. They should be able to compare the results obtained from different methods.

- Numerical integration methods (mid-ordinate, trapezoidal and Simpson's rule)
- Comparison of the results obtained from these methods
- Application to find the area of simple and compound shapes

#### Topic 3.3

Learners must be able to understand the methods used to calculate the volume of regular objects and be able to use the right units. Learners must be able to extend Simpson's rule and the trapezoidal rule (covered in Topic 3.2) to calculate the volume of irregular objects. They should also recognise that the Prismoidal rule, that can be used to find the volume of large excavations, is basically Simpson's rule applied to two strips.

- Volume of regular solids (prisms, cuboids, cylinders, cones, pyramids and spheres)
- Volume of irregular solids (Simpson's rule and trapezoidal rule)
- Volume of trenches/embankments.
- Prismoidal rule

### Learning outcome:

### 4. Use graphical and statistical techniques

## Topics

- 4.1 Graphical techniques
- 4.2 Data processing and presentation
- 4.3 Dispersion of data

#### Topic 4.1

Learners must understand the selection of scales for the x-axis and y-axis. They must be able to identify the x and y co-ordinates from given data and be able to plot experimental data. If the data exhibits linear correlation, they should be able to produce best-fit straight lines (approximately). They should be able to plot graphs of equations, and be able to find their solution. Learner must understand the technique to determine the gradients of straight lines and be able to find the equation of a straight-line graph.

- Cartesian and polar co-ordinates
- Linear and linear simultaneous equations
- Quadratic equations
- Gradient of straight lines
- Equation of straight-line graphs

#### Topic 4.2

Learners should be able to process raw data and produce frequency tables and grouped data. They must understand that the number of classes of a grouped data depends on the size of the data set. They must be able to determine the central tendency of data from grouped and ungrouped data and be able to compare the results. Learners should be able to produce a range of statistical diagrams from their analysis of data. These should include the following.

- Frequency tables
- Grouped data
- Mean, mode and median
- Statistical diagrams (bar charts, pie charts, frequency polygons and cumulative frequency polygons)

#### Topic 4.3

Learners must recognise the importance of the consistency of data. They must be able to apply a range of numerical measures of dispersion, and understand the limitation of these methods.

- Range
- Quartiles
- Inter-quartile range
- Variance
- Standard deviation

### Guidance for delivery

Tutors can use a range of teaching and learning methods to deliver this unit. These include lectures, demonstrations, discussions, group work, individual work and research using internet/library resources. The tutors should make sure that the learners spend enough time on practising the solution of problems covering all the topics. Learners must be given opportunities to apply the fundamental concepts to solve practical construction problems; the emphasis must be on practice - in the classroom as well as at home. Group work should be encouraged for students' interaction, but it is important that individual learners must have equal learning and assessment opportunities.

Learning outcome 1 should be covered first as it includes some basic techniques that underpin work in the other learning outcomes. Learning outcome 2 should be covered next as it deals with the properties of geometrical shapes and elementary trigonometry. Learners need to know these before learning to calculate perimeters, areas and volumes (learning outcome 3). For some tasks in learning

outcome 3 students should be encouraged to measure up a room and use the measurements to determine area, volume and other quantities. For delivering learning outcome 4, secondary data may be used rather than primary data. Learners should be encouraged to use spreadsheet for producing the statistical diagrams.

Tutors should go through as many examples as possible so that the basic concepts are clear to the learners. The examples should be based on construction activities, wherever possible. Tutors must encourage learners to produce solutions in a systematic way that includes all steps of calculations.

This unit should be undertaken at an early stage of the programme as the content of the unit underpins that of many other analytical units.

## Unit 320

## Further mathematics for the built environment

UAN:	R/506/5454
Level:	3
GLH:	60

### What is this unit about?

The purpose of this unit is for learners to apply mathematical and trigonometrical techniques, calculus and statistics to construction problems. Engineers working in the field of construction/civil engineering will apply higher mathematics to do their jobs successfully.

The teaching/learning of this unit starts with a number of fundamental techniques such as transposition, the binomial theorem and trigonometry. The skills developed will be used in other topics.

A number of formulae that are used in structural mechanics and soil mechanics, and other branches of civil engineering, have been derived using calculus. Bending moments in beams, deflection of beams and permeability of soils are some of the topics where calculus is used. This unit deals with the basic concepts in differential and integral calculus that learners need, in order to develop their skills in solving practical construction problems. This unit also gives learners an opportunity to study 'maxima and minima' which deals with the optimum use of materials/resources.

Civil engineers need to use appropriate mathematical techniques to determine important physical properties (centre of gravity, second moment of area, radius of gyration and others) of regular/irregular shapes and objects. The unit deals with the measures of central tendency, dispersion, and sampling distributions. The concept of elementary sampling theory will provide the basis for a more detailed study of quality control techniques.

Completion of this unit will give learners skills that they need in the construction industry and in higher education.

It is anticipated that learners would have taken **Unit 319 Mathematics for the Built Environment** prior to taking this unit

### Learning outcomes

In this unit, learners will be able to

1. understand the underpinning mathematical techniques of algebra and trigonometry
2. use calculus to solve practical problems in civil engineering
3. apply arithmetical techniques to determine the properties of sections in structural engineering
4. apply statistical techniques to civil engineering problems



## Scope of content

This section gives details of the scope of content to be covered in the teaching of the unit to ensure that all the learning outcomes can be achieved.

### Learning outcome:

#### 1. Understand the underpinning mathematical techniques of algebra and trigonometry

##### Topics

- 1.1 Transposition/evaluation of formulae Indices and transposition
- 1.2 Binomial theorem
- 1.3 Trigonometry

##### Topic 1.1

Learners must understand the process of transposition and be able to manipulate the formulae that technicians generally encounter in structural mechanics, geotechnics, soil mechanics and fluid mechanics.

- Transposition of simple formulae
- Transposition of complex formulae used in civil engineering practice
- Evaluation of formulae

##### Topic 1.2

Learners must understand what a binomial expression is, and must be able to expand a range of binomial expressions. They must understand the application of the theorem and be able to solve practical problems.

- Pascal's triangle
- Binomial expressions
- Binomial expansion
- Practical problems involving the Binomial theorem

##### Topic 1.3

Learners must understand the trigonometrical ratios of sine, cosine and tangent, and their reciprocals, as applied to a right-angled triangle. They should be able to prove trigonometric identities such as  $\sin^2 \theta + \cos^2 \theta = 1$  and  $\sin 2\theta = 2 \sin \theta \cos \theta$  and others.

Learners need to be aware that these identities may be used in integral calculus.

- Trigonometrical ratios (sine, cosine and tangent)
- Reciprocals of sine, cosine and tangent
- Trigonometric identities

### Learning outcome:

#### 2. Use calculus to solve practical problems in civil engineering

## Topics

- 2.1 Differential calculus
- 2.2 Integral calculus
- 2.3 Maxima and minima

### Topic 2.1

Learners must be aware that the gradient of a curve at a particular point may be calculated by geometrical techniques, or more accurately, by differentiation techniques. They must be able to differentiate a range of functions by selecting the appropriate technique. After learning the main methods they must be able to apply them to the solution of practical problems such as the maximum bending moment in a beam.

- Differentiation from first principles
- Basic differentiation – algebraic, trigonometric, exponential and logarithmic functions
- Differentiation of products/quotients/parts
- Second order derivatives
- Function of a function
- Function of a function by recognition
- Numerical values of differential coefficients
- Application to engineering problems

### Topic 2.2

Learners must understand that integration is the reverse of differentiation, and be able to undertake basic integration. They must be aware of the use of a constant in indefinite integrals and be able to evaluate an integral. They must be able to apply integration to finding the area under curves, and to other practical problems

- Basic – algebraic, trigonometric and exponential functions
- Indefinite and definite integrals
- Integration by substitution
- Integration by trigonometrical substitution
- Areas under curves
- Volumes about axes
- Application to civil engineering problems

### Topic 2.3

Learners must understand the meaning of the terms 'maximum turning point' and 'minimum turning point'. They should be able to find the second derivative and hence the nature of the turning points. They should be able to apply the basic concepts to solve a range of practical problems.

- Turning points
- Testing for maximum/minimum
- Second derivatives
- Practical applications of maxima and minima



### Learning outcome:

### 3. Apply arithmetical techniques to determine the properties of sections in structural engineering

#### Topics

- 3.1 Centroids of regular/irregular sections
- 3.2 Second moments of area
- 3.3 Polar second moments of area

#### Topic 3.1

Learners must understand the process of finding the centroid of regular and irregular structural/engineering sections. They must be aware of the use of centroids in engineering applications.

- First moment of area
- Centroids of areas by integration
- Centroid of the sector of a circle

#### Topic 3.2

Learners must understand that the second moment of area has an important application in structural mechanics. They must be able to differentiate between the second moment of area about the base and second moment of area about the centroid of a section. They must understand the parallel axis theorem and be able to apply it for a range of structural sections.

- Second moment of area
- The parallel axis theorem
- Section modulus
- Application to rectangular, triangular and circular sections

#### Topic 3.3

Learners must understand the difference between the second moment of area and the polar second moment of area. They must be able to determine radius of gyration and be able to use it for determining the polar second moment of area of a circular section/shaft.

- Polar second moment of area
- Radius of gyration
- Application to circular areas/shafts

### Learning outcome:

### 4. Apply statistical techniques to civil engineering problems

#### Topics

- 4.1 Measures of central tendency
- 4.2 Measures of dispersion
- 4.3 Sampling distributions

#### **Topic 4.1**

Learners must be able to process raw data and produce frequency tables and grouped data. Depending on the size of the data set they must be able to select the appropriate number of classes. They must be able to determine the central tendency of grouped and ungrouped data and be able to compare the results. They should be able to produce a range of statistical diagrams from their analysis of data.

- Measures of central tendency (mean, mode and median)
- Grouped and ungrouped data
- Statistical diagrams (bar charts, histograms, frequency curves, cumulative frequency curves)

#### **Topic 4.2**

Learners must recognise the importance of the consistency of data. They must be able to apply a range of numerical measures of dispersion and understand the limitation of some of these methods.

- Range
- Quartiles and deciles
- Inter-quartile range
- Variance
- Standard deviation

#### **Topic 4.3**

Learners must understand normal distribution and basic sampling and estimation theories. They should be able to apply these to solve a range of problems.

- Normal distribution
- Normal distribution tables
- Confidence limits

### **Guidance for delivery**

Tutors may use a range of teaching and learning methods to deliver this unit. These include lectures, demonstrations, discussions, group work, individual work and research using internet/library resources. The tutors should make sure that the learners spend enough time on practising the solution of problems covering all the topics. Learners must be given opportunities to apply the fundamental concepts to solve practical construction problems; the emphasis must be on practice - in the classroom as well as at home. Group work should be encouraged for students' interaction, but it is important that individual learners must have equal learning and assessment opportunities.

Learning outcome 1 (LO 1) should be covered first as it includes some basic techniques that underpin work in the other learning outcomes. Trigonometrical identities could be used later (LO 2) to solve complex problems in integration. Learning outcome 2 should be covered next as it covers differentiation, integration and, maxima and minima which form an essential part of this unit. Integration of algebraic and trigonometric functions forms the basis of determining the position of centroid of a range of sections in LO 3. Learning outcome 3 deals with the physical properties of

regular and irregular sections. Physical properties of regular structural sections are published in several books and journals, but learners must be able to use the first moment of area and the second moment of area to find the physical properties of irregular sections. This work is covered in LO 3. For delivering learning outcome 4, secondary data may be used rather than the primary data. For supporting learners with learning disability adequate resources must be made available. Tutors can arrange regular tutorials and workshops, and use formative tests/coursework to check the progress of learners.

Learners must be aware that the topics learnt in this unit have application in several units that they may learn in higher education. The delivery of this unit should be undertaken after learners have completed **Unit 319 Mathematics for the Built Environment**.

## 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](http://www.cityandguilds.com).

### *City & Guilds Centre Manual*

This document provides guidance for organisations wishing to become City & Guilds approved centres, as well as information for approved centres delivering City & Guilds qualifications. It covers the centre and qualification approval process as well as providing guidance on delivery, assessment and quality assurance for approved centres.

It also details the City & Guilds requirements for ongoing centre and qualification approval, and provides examples of best practice for centres. Specifically, the document includes sections on:

- the centre and qualification approval process
- assessment, internal quality assurance and examination roles at the centre
- registration and certification of candidates
- non-compliance and malpractice
- complaints and appeals
- equal opportunities
- data protection
- management systems
- maintaining records
- internal quality assurance
- external quality assurance.

### *Our Quality Assurance Requirements*

This document explains the requirements for the delivery, assessment and awarding of our qualifications. All centres working with City & Guilds must adopt and implement these requirements across all of their qualification provision. Specifically, this document:

- specifies the quality assurance and control requirements that apply to all centres
- sets out the basis for securing high standards, for all our qualifications and/or assessments
- details the impact on centres of non-compliance

The **centre homepage** section of the City & Guilds website also contains useful information on

- **Walled Garden:** how to register and certificate candidates on line
- **Events:** dates and information on the latest Centre events
- **Online assessment:** how to register for e-assessments.

## Useful contacts

<b>UK learners</b> General qualification information	<b>E: <a href="mailto:learnersupport@cityandguilds.com">learnersupport@cityandguilds.com</a></b>
<b>International learners</b> General qualification information	<b>E: <a href="mailto:intcg@cityandguilds.com">intcg@cityandguilds.com</a></b>
<b>Centres</b> Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	<b>E: <a href="mailto:centresupport@cityandguilds.com">centresupport@cityandguilds.com</a></b>
<b>Single subject qualifications</b> Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	<b>E: <a href="mailto:singlesubjects@cityandguilds.com">singlesubjects@cityandguilds.com</a></b>
<b>International awards</b> Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	<b>E: <a href="mailto:intops@cityandguilds.com">intops@cityandguilds.com</a></b>
<b>Walled Garden</b> Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	<b>E: <a href="mailto:walledgarden@cityandguilds.com">walledgarden@cityandguilds.com</a></b>
<b>Employer</b> Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	<b>T: +44 (0)121 503 8993</b> <b>E: <a href="mailto:business@cityandguilds.com">business@cityandguilds.com</a></b>

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## City & Guilds Group

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