

**BTEC**

# **HIGHER NATIONALS**

## **Construction**

### **Specification**

First Teaching from September 2018

First Certification from September 2019



**Higher National  
Certificate Lvl 4**

**Higher National  
Diploma Lvl 5**

## **About Pearson**

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## Summary of changes in Pearson BTEC Higher Nationals in Construction Issue 4

Summary of changes made between previous issue and this current issue	Page number
<p><i>1.8 Collaborative development</i></p> <p>List of collaborators presented in alphabetical order.</p> <p>Burton and South Derbyshire College added to the list.</p>	<p>5</p> <p>6</p>
<p><i>2.3 Aims of the Pearson BTEC Level 4 Higher National Certificate in Construction</i></p> <p>Paragraph text amended from four core units to three core units.</p> <p><i>Unit 50: Alternative Sustainable Solutions in Construction</i>, added to optional unit list.</p> <p>Important note included, advising that <i>Unit 50: Alternative Sustainable Solutions in Construction</i> is a 30 credit, rather than 15 credit unit.</p>	<p>9</p> <p>10</p>
<p><i>Unit 50: Alternative Sustainable Solutions in Construction</i>, added</p>	<p>455</p>

If you need further information on these changes or what they mean, contact us via our website at: [qualifications.pearson.com/en/support/contact-us.html](http://qualifications.pearson.com/en/support/contact-us.html).



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# 1 Introduction

BTEC is one of the world's most recognised applied learning brands, engaging students in practical, interpersonal and thinking skills, for more than thirty years.

BTECs are work-related qualifications for students taking their first steps into employment, or for those already in employment and seeking career development opportunities. BTECs provide progression into the workplace either directly or via study at university and are also designed to meet the employer's needs. Therefore, Pearson BTEC Higher National qualifications are widely recognised by industry and higher education as the principal vocational qualification at Levels 4 and 5.

When developing the Pearson BTEC Higher National qualifications in Construction, we collaborated with a wide range of students, employers, higher education providers, colleges and subject experts to ensure that the new qualifications meet their needs and expectations. We also worked closely with the relevant Professional Bodies, to ensure alignment with recognised professional standards.

There is now a greater emphasis on employer engagement and work readiness. The new BTEC Higher National qualifications in Construction are designed to reflect this increasing need for high quality professional and technical education pathways at Levels 4 and 5, thereby providing students with a clear line of sight to employment and to progression to a degree at Level 6.

## 1.1 The student voice

Students are at the heart of what we do. That is why, from the outset, we consulted with students in the development of these qualifications. We involved them in writing groups, sought their feedback, and added their voices and views to those of other stakeholders.

The results, we believe, are qualifications that will meet the needs and expectations of students worldwide.

## 1.2 Why choose Pearson BTEC Higher Nationals?

Pearson BTEC Higher Nationals are designed to help students secure the knowledge, skills and behaviours needed to succeed in the workplace. They represent the latest in professional standards and provide opportunities for students to develop behaviours for work, for example by undertaking a group project, or responding to a client brief. A student may even achieve exemption from professional or vendor qualifications, or student membership of selected professional bodies, to help them on their journey to professional competence.

At the same time the BTEC Higher Nationals are intended to keep doors open for future study should a student wish to progress further in their education after their Level 5 study. They do this by allowing space for the development of higher education study skills, such as the ability to research. Clear alignment of level of demand with the Framework for Higher Education qualification descriptors at Level 4 and Level 5 means that students wishing to progress to level 6 study should feel better prepared. The Pearson BTEC Higher Nationals address these various requirements by providing:

- A range of general and specialist units, both core and optional, each with a clear purpose, so there is something to suit each student's choice of programme and future progression plans
- Fully revised content that is closely aligned with the needs of employers, Professional Bodies, vendors and higher education for a skilled future workforce
- Learning outcomes mapped against Professional Body standards and vendor accreditation requirements, where appropriate
- Assessments and projects chosen to help students progress to the next stage (this means some are set by the Centre to meet local needs, while others are set by Pearson)
- An approach to demand at Levels 4 and 5 which is aligned with the Framework for Higher Education Qualifications (FHEQ)
- Support for students and tutors including Schemes of Work and Example Assessment Briefs.

### **1.3 HN Global**

Pearson BTEC Higher Nationals are supported by a specially designed range of digital resources, to ensure that tutors and students have the best possible experience during their course. These are available from the HN Global website, [www.ighernationals.com](http://www.ighernationals.com)

With HN Global, tutors can access Programme Specifications which contain useful information on programme planning and quality assurance processes. Tutors can also view Schemes of Work and Example Assessment Briefs, helping them create meaningful courses and assessments. HN Global also allows tutors to create and annotate reading lists for their students and keep up-to-date on the latest news regarding HN programmes.

## 1.4 Qualification titles

### Pearson BTEC Level 4 Higher National Certificate in Construction

Specialist pathways are included within brackets in the qualification title:

- Pearson BTEC Level 4 Higher National Certificate in Construction (Construction)
- Pearson BTEC Level 4 Higher National Certificate in Construction (Civil Engineering)
- Pearson BTEC Level 4 Higher National Certificate in Construction (Building Services – Heating, Ventilation and Air Conditioning)
- Pearson BTEC Level 4 Higher National Certificate in Construction (Building Services – Electrical)
- Pearson BTEC Level 4 Higher National Certificate in Construction (Surveying)

### Pearson BTEC Level 5 Higher National Diploma in Construction

Specialist pathways are included within brackets in the qualification title:

- Pearson BTEC Level 5 Higher National Diploma in Construction (Construction – Management)
- Pearson BTEC Level 5 Higher National Diploma in Construction (Construction – Architectural Technology)
- Pearson BTEC Level 5 Higher National Diploma in Construction (Civil Engineering)
- Pearson BTEC Level 5 Higher National Diploma in Construction (Building Services Engineering – Heating, Ventilation & Air Conditioning)
- Pearson BTEC Level 5 Higher National Diploma in Construction (Building Services Engineering – Electrical)
- Pearson BTEC Level 5 Higher National Diploma in Construction (Surveying)

## 1.5 Qualification codes

Ofqual Regulated Qualifications Framework (RQF) qualification numbers:

Pearson BTEC Level 4 Higher National Certificate in Construction: **603/3416/2**

Pearson BTEC Level 5 Higher National Diploma in Construction: **603/3417/4**

## 1.6 Awarding institution

Pearson Education Ltd.

## 1.7 Key features

Pearson BTEC Higher National qualifications in Construction offer the following:

- a stimulating and challenging programme of study that will be both engaging and memorable for students
- the essential subject knowledge that students need to progress successfully into further study and the world of work
- a simplified structure: students undertake a substantial core of learning in the Higher National Certificate and can build on this in the Higher National Diploma, with optional units linked to their specialist area of study
- six specialist pathways in the Level 5 Diploma, so there is something to suit each student's preference of study and future progression plans
- refreshed content that is closely aligned with Professional Body, vendor, employer and higher education needs
- assessments that consider cognitive skills (what students know) along with effective and applied skills (respectively how they behave and what they can do)
- unit-specific grading
- Pearson-set assignments
- a diverse approach to assessment that supports progression to Level 6 and also allows Centres to offer assessment relevant to the local economy, thereby accommodating and enhancing different learning styles
- quality assurance measures – as outlined in Sections 6 and 7 – to ensure that all stakeholders (e.g. Professional Bodies, vendors, universities, businesses, colleges and students) can feel confident in the integrity and value of the qualifications
- a qualification designed to meet the needs and expectations of students aspiring to work in an international business environment.

### Qualification frameworks

Pearson BTEC Higher National qualifications are designated higher education qualifications in the UK. They are aligned to the Framework for Higher Education Qualifications (FHEQ) in England, Wales and Northern Ireland, and Quality Assurance Agency (QAA) Subject Benchmark Statements. These qualifications are part of the UK Regulated Qualifications Framework (RQF).

## 1.8 Collaborative development

Students completing their Pearson BTEC Higher Nationals in Construction will be aiming to go on to employment or progress to the second or final year at university. Therefore, it was essential that we developed these qualifications in close collaboration with experts from professional bodies and universities, and with the providers who will be delivering the qualifications.

We are very grateful to the university and further education tutors, employers, professional body representatives and other individuals who have generously shared their time and expertise to help us develop these new qualifications:

- Arup (multinational architecture, engineering and consulting firm)
- Autodesk (global architecture, engineering and construction software vendor).
- Bath College
- Bentley (global architecture, engineering and construction software vendor)
- Burton and South Derbyshire College
- Chartered Association of Building Engineers (CABE)
- Chartered Institute of Architectural Technologists (CIAT)
- Construction Industry Training Board (CITB)
- Cundall (International, multi-disciplinary consulting engineers)
- Engineering Construction Industry Training Board (ECITB)
- Institution of Civil Engineers (ICE)
- Institution of Structural Engineers (iStructE)
- Leeds College of Building
- London South Bank University
- Royal Academy of Engineering (RAE)
- Royal Institution of Chartered Surveyors (RICS)
- St. Modwen Homes
- University College London
- Vinci Construction (multinational construction and facilities company)

## 1.9 Professional body requirements

This qualification has been developed to meet the requirements of the following Professional Bodies:

- Institution of Civil Engineers
- Institution of Structural Engineers
- Royal Institution of Chartered Surveyors
- Chartered Institute of Building
- Chartered Institute of Architectural Technologists
- Chartered Institution of Building Services Engineers
- Chartered Institute of Plumbing and Heating and Engineers

## 1.10 Professional body exemptions

In developing the Pearson BTEC Higher National qualifications in Construction, we have sought to align this qualification with the following Professional Bodies:

- Institution of Civil Engineers
- Institution of Structural Engineers
- Royal Institution of Chartered Surveyors
- Chartered Institute of Building
- Chartered Institute of Architectural Technologists
- Chartered Institution of Building Services Engineers
- Chartered Institute of Plumbing and Heating and Engineers

With their agreement we have secured exemptions from certain memberships for students achieving Pearson BTEC Higher National qualifications in Construction. This adds value to the qualification by offering students access to Continuing Professional Development.



## 2 Programming purpose and objectives

### 2.1 Purpose of the BTEC Higher Nationals in Construction

The purpose of BTEC Higher Nationals in Construction is to develop students as professional, self-reflecting individuals able to meet the demands of employers in the Construction sector and adapt to a constantly changing world. The qualifications aim to widen access to higher education and enhance the career prospects of those who undertake them.

### 2.2 Objectives of the BTEC Higher Nationals in Construction

The objectives of the Pearson BTEC Higher Nationals in Construction are as follows:

- to equip students with Construction skills, knowledge and the understanding necessary to achieve high performance in the global Construction sector
- to provide education and training for a range of careers in Construction, including civil engineering, building services engineering, quantity surveying, construction management and architectural technology
- to provide students with an understanding of the way technologies are transforming the industries of Construction and prepare them to work with these technologies
- to provide insight and understanding into diversity of roles with Construction, recognising the importance of collaboration at all levels
- to equip students with knowledge and understanding of culturally diverse organisations, cross-cultural issues, diversity and values
- to provide opportunities for students to enter or progress in employment in Construction, or progress to higher education qualifications; such as an Honours degree in Construction or a related area
- to provide opportunities for students to develop the skills, techniques and personal attributes essential for successful working lives
- to support students to understand the local, regional and global context of Construction and, for those students with a global outlook, to aspire to international career pathways
- to provide students with opportunities to address contemporary issues facing the industry, and society at large; with particular emphasis on sustainability and the environment, recognising the role that Construction plays in addressing these issues

- to provide opportunities for students to achieve a nationally-recognised professional qualification within their chosen area of specialisation
- to provide opportunities for students to achieve vendor accredited certifications
- to offer students the chance of career progression in their chosen field, with particular emphasis on achieving management-level positions, professional recognition and beyond
- to allow flexibility of study and to meet local or specialist needs
- to offer a balance between employability skills and the knowledge essential for students with entrepreneurial, employment or academic aspirations
- to provide students with opportunities to engage in an industry-recognised apprenticeship scheme that aligns with their employer's needs and their own career aspirations
- to provide students with the context in which to consider professional ethics and their relation to personal, professional and statutory responsibilities within the industry.

We aim to meet these objectives by:

- providing a thorough grounding in Construction principles at Level 4, within general areas of specialism, that lead the student to a range of specialist progression pathways at Level 5 relating to individual professions within the Construction sector
- enabling progression to a university degree by supporting the development of appropriate academic study skills and personal development planning
- enabling progression to further professional qualifications in specific Construction areas by mapping to units in a range of vendor accredited certificates.

### **Who is this qualification for?**

The Pearson BTEC Higher National qualifications in Construction are aimed at students wanting to continue their education through applied learning. Higher Nationals provide a wide-ranging study of the Construction sector and are designed for students who wish to pursue or advance their career in Construction or related fields. In addition to the knowledge, understanding and skills that underpin the study of the Construction sector, Pearson BTEC Higher Nationals in Construction give students experience of the breadth and depth of the sector that will prepare them for further study or training in Construction related fields.

## 2.3 Aims of the Pearson BTEC Level 4 Higher National Certificate in Construction

The Pearson BTEC Level 4 Higher National Certificate in Construction offers students a broad introduction to the subject area via a mandatory core of learning, as well as units within general 'pathways', while allowing for the acquisition of skills and experience through the selection of a further (Level 4) unit across a range of occupational sectors. This effectively builds underpinning core skills, with general specialisation; preparing the student for further specialisation at Level 5. Students will gain a wide range of sector knowledge tied to practical skills gained in research, self-study, directed study and workplace scenarios.

At Level 4 students develop a broad knowledge and awareness of key aspects of the Construction sector through three core units, which includes one unit assessed through a Pearson-set assignment. The core units are:

- 1 – Individual Project (Pearson Set)
- 2 – Construction Technology
- 4 – Construction Practice and Management.

Depending on the 'specialist pathway', at Level 4, students will undertake a further three specialist units (related to their Level 4 Pathway) from:

- 3 – Science & Materials
- 5 – Legal & Statutory Responsibilities in Construction
- 6 – Construction Information (Drawing, Detailing, Specification)
- 8 – Mathematics for Construction
- 9 – Principles of Heating Services Design & Installation
- 10 – Principles of Ventilation & Air Conditioning Design & Installation
- 11 – Measurement & Estimating
- 12 – Financial Management & Business Practices in Construction
- 14 – Building Information Modelling
- 16 – Principles of Alternative Energy
- 19 – Principles of Electrical Design & Installation
- 20 – Principles of Structural Design
- 48 – Scientific Principles for Building Services.

The Centre can also choose a further optional unit(s) at Level 4 from the following:

- 7 – Surveying, Measuring & Setting-out
- 13 – Tender & Procurement
- 14 – Building Information Modelling
- 16 – Principles of Alternative Energy
- 18 – Civil Engineering Technology
- 19 – Principles of Electrical Design & Installation
- 50 – Alternative sustainable solutions in Construction.

Important note: *Unit 50: Alternative Sustainable Solutions in Construction* is a 30 credit unit. Therefore, it is important to review the rules of combination of each pathway to ensure that the pathway allows for a 30 credit, rather than 15 credit unit.

Specialist Units from a different pathway can also be used as Optional Units. Specific information can be found in the Programme Structure (see section 4) Graduates successfully completing the Pearson BTEC Level 4 Higher National Certificate in Construction will be able to demonstrate a sound knowledge of the basic concepts of Construction. They will be able to communicate accurately and appropriately, and they will have the qualities needed for employment that requires some degree of personal responsibility. They will have developed a range of transferable skills to ensure effective team working, independent initiatives, organisational competence and problem-solving strategies. They will be adaptable and flexible in their approach to Construction, show resilience under pressure, and meet challenging targets within a given resource.

## **2.4 Aims of the Pearson BTEC Level 5 Higher National Diploma in Construction**

The Pearson BTEC Level 5 Higher National Diploma in Construction offers students 6 'specialist pathways' designed to support progression into relevant occupational areas or on to degree-level study. These pathways are linked to Professional Body standards and vendor accredited certification (where appropriate) and can provide professional status and progression to direct employment.

The Pearson BTEC Level 5 Higher National Diploma offers the following specialist pathways for students who wish to concentrate on a particular aspect of Construction:

- Construction – Management
- Construction – Architectural Technology
- Building Services – Electrical
- Building Services – Heating, Ventilation & Air Conditioning

- Civil Engineering
- Surveying.

Holders of the Pearson BTEC Level 5 Higher National Diploma will have developed a sound understanding of the principles in their 'specialist pathway' of study and will have learned to apply those principles more widely. They will have learned to evaluate the appropriateness of different approaches to solving problems. They will be able to perform effectively in their chosen field and will have the qualities necessary for employment in situations requiring the exercise of personal responsibility and decision-making.

## **2.5 What could these qualifications lead to?**

The Pearson BTEC Level 4 Higher National Certificate in Construction provides a solid grounding in Construction, vendor accredited certification and Professional Body membership, upon which students can build; should they decide to continue their studies beyond the Certificate stage. The Pearson BTEC Level 5 Higher National Diploma allows students to specialise by committing to specific career paths and progression routes to degree-level study. In addition, the qualifications may provide links to industry-related and employer-supported apprenticeship schemes that can provide further opportunities for enhanced employability.

On successful completion of the Pearson BTEC Level 5 Higher National Diploma, students can develop their careers in the Construction sector through:

- Entering employment
- Continuing existing employment
- Linking with the appropriate vendor accredited certificates
- Committing to Continuing Professional Development (CPD)
- Progressing to university
- Progressing to a higher apprenticeship scheme, in conjunction with progression to a university degree course.

### 2.5.1 Progression to university

The Pearson BTEC Level 5 Higher National Diploma in Construction is recognised by higher education providers as meeting admission requirements for many relevant engineering degree programmes in subject specialisms such as:

- BSc Civil Engineering
- BSc Building Surveying
- BA/BSc Quantity Surveying
- BA/BSc Architectural Technology
- BA/BSc Building Services Engineering
- BA/BSc Construction Management
- BA/BSc Project Management
- BA/BSc Facilities Management
- BA/BSc Structural Engineering

### University recognition and articulations

We work with a range of higher education institutions around the world that recognise and accept BTEC Higher Nationals as a qualification for entry onto an undergraduate degree. Many universities allow advanced entry onto the second or third year of a degree, and agreements can include credit transfer, articulation and case-by-case admission. Students should be aware that university admission criteria are always subject to change and remain at the discretion of the institution. Students should take time to understand the course entry requirements for subject, year and grade before applying. For more information on entry requirements, including 2+1 articulations, please visit: <https://www.highernationals.com/degree-finder>.

## 2.5.2 Employment

After completing a Pearson BTEC Level 4 Higher National Certificate or Level 5 Higher National Diploma, students can also progress directly into employment. The skills offered as part of the Pearson BTEC Level 5 Higher National Diploma can provide graduates with the opportunity to work in many different areas of the Construction sector. Below are some examples of job roles each qualification could lead to.

Pathway	Job Roles
Construction – Management	Assistant Design Co-ordinator Design & Build Co-ordinator Construction Site Supervisor Construction Design Technician Site Manager Project Manager Health & Safety Manager Planning Supervisor
Construction – Architectural Technology	Construction Technician Architectural Technologist Architectural Draftsperson Information Manager Architectural Technician Architectural Designer
Building Services – HVAC	Heating/Cooling System Designer Heating/Cooling System Installer Acoustics Designer/Installer
Building Services – Electrical	Building Services Engineering Technician Electrical System Designer/Installer Lighting System Designer/Installer
Civil Engineering	Site Engineering Technician Structural Engineering Design Civil Engineering Design Transport Engineering Design
Quantity Surveying	Quantity Surveyor Building Surveyor Land Surveyor

## 2.6 Use of maths and English within the curriculum

Those working within the construction sector cannot just rely on their technical skills and must ensure all skills are relevant to increase employment opportunities. They will be required to communicate appropriately with stakeholders throughout their career and the ability to use maths and English in a professional context is an essential employability skill that must be developed at all levels of study.

Development of essential maths and English skills are embedded throughout these qualifications in accordance with industry requirements, and below are some examples of how these skills are developed in the BTEC Higher Nationals Curriculum:

- Written reports
- Formal presentations
- Formal and informal conversations
- Use of professional, sector-specific language
- Measuring accurately
- Understanding scale
- Calculating material requirements, costs, time
- Using formulas appropriate to a given problem.

Some aspects of construction require higher level maths skills than others, but throughout their studies students will be using some level of maths within the curriculum. It is vital that students taking a BTEC Higher National in Construction are aware that these skills will be required throughout their studies, and as part of learning activities and assessments to ensure their skills are in line with current industry standards.

## **2.7 How Pearson BTEC Higher Nationals in Construction provide both transferable employability skills and academic study skills**

Students need both relevant qualifications and employability skills to enhance their career prospects and contribute to their personal development. Pearson BTEC Higher National Construction qualifications embed throughout the programme the development of key skills, attributes and strengths required by 21<sup>st</sup>-century employers.

Where employability skills are referred to in this specification, this generally refers to skills in five main categories:

- **Cognitive and problem-solving skills:** critical thinking, approaching non-routine problems by applying expert and creative solutions, use of systems and digital technology, generating and communicating ideas creatively.
- **Intrapersonal skills:** self-management, adaptability and resilience, self-monitoring and self-development, self-analysis and reflection, planning and prioritising.
- **Interpersonal skills:** effective communication and articulation of information, working collaboratively, negotiating and influencing, self-presentation.



- **Commercial skills:** sector awareness, budget management/monitoring.
- **Business skills:** awareness of types of companies, company formation, calculating fees, business management.

Pearson Example Assessment Briefs make recommendations for a range of real or simulated assessment activities, for example group work where appropriate, to encourage the development of collaborative and interpersonal skills or a solution-focused case study to provide the opportunity to develop cognitive skills. There are specific requirements for the assessment of these skills, as relevant, within the assessment grids for each unit. Example Assessment Briefs are for guidance and support only and **must** be customised and amended according to localised needs and requirements. All assignments must still be verified as per the internal verification process.

Students can also benefit from opportunities for deeper learning, where they are able to make connections between units and select areas of interest for detailed study. In this way Pearson BTEC Higher Nationals provide a career-related context in which students can develop the knowledge and academic study skills required for progression to university degree courses, including:

- active personal research skills
- effective writing skills
- analytical skills
- critical thinking and reflective practice
- evidence-based practice
- creative problem-solving
- decision-making
- team building
- exam preparation skills
- digital literacy
- competence and capability in practice-based skills in the workplace
- competence in assessment methods used in higher education.

To support you in developing these skills in your students, we have developed a map of higher education relevant transferable and academic study skills, available in *Appendix 6*.

## 3 Planning your programme

### 3.1 Delivering the Higher Nationals in Construction

**You play a central role in helping your students to choose the right Pearson BTEC Higher National qualification.**

You should assess your students very carefully to ensure that they take the right qualification and the right pathways or optional units, to allow them to progress to the next stage. You should check the qualification structures and unit combinations carefully when advising students.

You will need to ensure that your students have access to a full range of information, advice and guidance in order to support them in making the necessary qualification and unit choices. When students are recruited, you need to give them accurate information on the title and focus of the qualification for which they are studying.

### 3.2 Entry requirements and admissions

Although Pearson do not specify formal entry requirements, as a centre it is your responsibility to ensure that the students you recruit have a reasonable expectation of success on the programme.

For students who have recently been in education, the entry profile is likely to include one of the following:

- a BTEC Level 3 qualification in Construction (or a related subject)
- a GCE Advanced Level profile that demonstrates strong performance in a relevant subject or adequate performance in more than one GCE subject; this profile is likely to be supported by GCSE grades A\* to C and/or 9 to 4 (or equivalent) in subjects such as maths and English
- other related Level 3 qualifications
- an Access to Higher Education Diploma awarded by an approved further education institution
- related work experience
- an international equivalent of the above.

Centres may wish to consider applicants' prior learning when assessing their acceptance on a Pearson BTEC Higher National, through Recognition of Prior Learning. (For further information please refer to *Section 8* of this document.)

### 3.2.1 English language requirements

Pearson's mission is to help people make more of their lives through learning. In order for students to be successful on Pearson BTEC Higher National qualifications which are **both** taught and assessed in English, it is critical that they have an appropriate level of English language skills.

The following clarifies the requirements for all centres when recruiting applicants on to new Pearson BTEC Higher National qualifications.

All centres delivering the new Pearson BTEC Higher National qualifications must ensure that all students who are non-native English speakers and who have not undertaken their final two years of schooling in English, can demonstrate capability in English at a standard equivalent to the levels identified below, before being recruited to the programme **where the programme is both taught and assessed in English:**

- Common European Framework of Reference (CEFR) level B2
- PTE **51**
- IELTS **5.5**; Reading and Writing must be at **5.5**
- or equivalent.

It is up to the centre to decide what proof will be necessary to evidence individual student proficiency.

The following clarifies the requirements for all centres when recruiting applicants on to new Pearson BTEC Higher National qualifications which are taught in a language other than English, but are assessed in English.

All centres delivering the new Pearson BTEC Higher National qualifications **wholly or partially** in a language other than English, but who are assessed in English, must ensure that all students can demonstrate capability in English at a standard equivalent to the levels identified below, on completion of the programme:

- Common European Framework of Reference (CEFR) level B2
- PTE **51**
- IELTS **5.5**; Reading and Writing must be at **5.5**
- or equivalent.

It is up to the centre to decide what proof will be necessary to evidence individual student proficiency.

### 3.2.2 Centre approval

To ensure that centres are ready to assess students and that we can provide the support that is needed, all centres must be approved before they can offer these qualifications. For more information about becoming a centre and seeking approval to run our qualifications, please visit the support section on our website (<http://qualifications.pearson.com>).

### 3.2.3 Level of sector knowledge required

We do not set any requirements for tutors, but we do recommend that centres assess the overall skills and knowledge of the teaching team, which should be relevant, up to date and at the appropriate level.

### 3.2.4 Resources required

As part of your centre approval, you will need to show that the necessary material resources and work spaces are available to deliver BTEC Higher Nationals. For some units, specific resources are required, this is clearly indicated in the unit descriptors.

### 3.2.5 HN Global support

HN Global is an online resource that supports centre planning and delivery of BTEC Higher Nationals by providing appropriate teaching and learning resources. For further information see *Sections 5 and 6* of this Programme Specification.

### 3.2.6 Modes of delivery

Subject to approval by Pearson, centres are free to deliver BTEC Higher Nationals using modes of delivery that meet the needs of their students. We recommend making use of a wide variety of modes, including:

- full-time
- part-time
- blended learning.

### 3.2.7 Recommendations for employer engagement

BTEC Higher Nationals are vocational qualifications and as an approved centre you are encouraged to work with employers on the design, delivery and assessment of the course. This will ensure that students enjoy a programme of study that is engaging and relevant, and which equips them for progression. There are suggestions in *Section 5.2* about how employers could become involved in delivery and/or assessment, but these are not intended to be exhaustive and there will be other possibilities at a local level.

### 3.2.8 Support from Pearson

We provide a range of support materials, including Schemes of Work and Example Assessment Briefs, with supporting templates. You will be allocated an External Examiner early in the planning stage, to support you with planning your assessments, and there will be training events and support from our Subject Leads.

### 3.2.9 Student employability

All Pearson BTEC Higher Nationals have been designed and developed with consideration of National Occupational Standards, where relevant, and have been aligned to professional body and higher apprenticeship standard (see *Section 1.9*).

Employability skills such as team working and entrepreneurialism as well as practical hands-on skills have been built into the design of the learning aims and content. This gives you the opportunity to use relevant contexts, scenarios and materials to enable students to develop a portfolio of evidence demonstrating the breadth of their skills and knowledge in a way that equips them for employment.

## 3.3 Access to study

This section focuses on the administrative requirements for delivering a Pearson BTEC Higher National qualification. It will be of value to Quality Nominees, Programme Leaders and Examinations Officers.

Our policy regarding access to our qualifications is that:

- they should be available to everyone who is capable of reaching the required standards
- they should be free from any barriers that restrict access and progression.

There should be equal opportunities for all those wishing to access the qualifications. We refer centres to our Pearson *Equality and Diversity Policy*. Centres are also required to recruit students to Higher National programmes with integrity. We refer centres to our Pearson *Recruiting with Integrity* guide. Both policies can be found in the support section of our website (<http://qualifications.pearson.com>).

Centres will need to make sure that applicants have relevant information and advice about the qualification, to make sure it meets their needs. Centres should review the applicant's prior qualifications and/or experience to consider whether this profile shows that they have the potential to achieve the qualification. For students with disabilities and specific needs, this review will need to take account of the support available to the student during the teaching and assessment of the qualification. For further guidance and advice please refer to *Section 9* on reasonable adjustments.

### **3.4 Student registration and entry**

All students must be registered for the qualification, and appropriate arrangements made for internal and external verification. For information on making registrations for the qualification, you will need to refer to the information manual available in the support section of our website (<http://qualifications.pearson.com>).

Students can be formally assessed only for a qualification on which they are registered. If students' intended qualifications change (for example, if a student decides to choose a different specialist pathway), then the centre must transfer the student to the chosen pathway appropriately. Please note that student work cannot be sampled if the student is not registered or is registered on an incorrect pathway.

### **3.5 Access to assessments**

Assessments need to be administered carefully, to ensure that all students are treated fairly, and that results and certification are issued on time, allowing students to move on to chosen progression opportunities.

Our equality policy requires that all students should have equal opportunity to access our qualifications and assessments, and that our qualifications are awarded in a way that is fair to every student. We are committed to making sure that:

- students with a protected characteristic (as defined in legislation) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic
- students achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Further information on access arrangements can be found on the Joint Council for Qualifications website ([www.jcq.org.uk](http://www.jcq.org.uk)).

### **3.6 Administrative arrangements for internal assessment**

#### **3.6.1 Records**

You are required to retain records of assessment for each student. Records should include assessments taken, decisions reached and any adjustments or appeals. Further information on quality assurance and assessment can be found in our UK and international guides available in the support section on our website (<http://qualifications.pearson.com>).

We may ask to audit your records, so they must be retained as specified. All student work must be retained for a minimum of 12 weeks after certification has taken place.

### 3.6.2 Reasonable adjustments to assessment

A reasonable adjustment is one that is made before a student takes an assessment, to ensure that he or she has fair access to demonstrate the requirements of the assessments.

You are able to make adjustments to internal assessments to take account of the needs of individual students. In most cases this can be achieved through a defined time extension or by adjusting the format of evidence. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable. You need to plan for time to make adjustments, if necessary.

Further details on how to make adjustments for students with protected characteristics are available on the support section of our website (<http://qualifications.pearson.com>).

### 3.6.3 Special consideration

Special consideration is given after an assessment has taken place for students who have been affected by adverse circumstances, such as illness, and require an adjustment of grade to reflect normal level of attainment. You must operate special consideration in line with Pearson policy (see previous paragraph). You can provide special consideration related to the period of time given for evidence to be provided, or for the format of the assessment (if it is equally valid). You may not substitute alternative forms of evidence to that required in a unit, or omit the application of any assessment criteria to judge attainment. Pearson can consider applications for special consideration in line with the policy, which can be found in the document linked above.

Please note that your centre must have a policy for dealing with mitigating circumstances, such as if students are affected by adverse situations, such as illness, which result in non-submission or late submission of assessment.

### 3.6.4 Appeals against assessment

Your centre must have a policy for dealing with appeals from students. These appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy could be a consideration of the evidence by a Programme Leader or other member of the programme team. The assessment plan should allow time for potential appeals after assessment decisions have been given to students. If there is an appeal by a student, you must document the appeal and its resolution. Students have a final right of appeal to Pearson, but only if the procedures that you have put in place have been followed.

Further details of our policy on enquiries and appeals is available on the support section of our website (<http://qualifications.pearson.com>).

If your centre is located in England or Wales and the student is still dissatisfied with the final outcome of their appeal he or she can make a further appeal to the Office of the Independent Adjudicator (OIA) by emailing: enquiries@oiahe.org.uk. In Northern Ireland a further appeal may be lodged with the Northern Ireland Public Service Ombudsman (NIPSO) by emailing: nipso@nipso.org.uk

### **3.7 Dealing with malpractice in assessment**

Malpractice' means acts that undermine the integrity and validity of assessment, the certification of qualifications and/or may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actual or attempted actions of malpractice by learners, centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, centre staff or centres where malpractice or attempted malpractice has been proven.

Malpractice may occur or be suspected in relation to any unit or type of assessment within a qualification. For further details on malpractice and advice on preventing malpractice by learners, please see Pearson's Centre Guidance: Dealing with Malpractice, available on our website.

The procedures we ask you to adopt vary between units that are internally assessed and those that are externally assessed.

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. The Centre Guidance: Dealing with Malpractice document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe a centre is failing to conduct internal assessment according to our policies. The above document gives further information and examples, and details the penalties and sanctions that may be imposed.

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.



### 3.7.1 Internally assessed units

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Students must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. Full information on dealing with malpractice and the actions we expect you to take is available on the support section of our website (<http://qualifications.pearson.com>).

Pearson may conduct investigations if it is believed that a centre is failing to conduct internal assessment according to Pearson policies. The above document gives further information, provides examples, and details the penalties and sanctions that may be imposed.

### 3.7.2 Student malpractice

The head of centre is required to report incidents of suspected learner malpractice that occur during Pearson qualifications. We ask centres to complete JCQ Form M1 ([www.jcq.org.uk/malpractice](http://www.jcq.org.uk/malpractice)) and email it with any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc) to the Investigations Processing team at [candidatemalpractice@pearson.com](mailto:candidatemalpractice@pearson.com). The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

### 3.7.3 Staff and centre malpractice

The head of centre is required to inform Pearson's Investigations team of any incident of suspected malpractice (which includes maladministration) by centre staff, before any investigation is undertaken. The head of centre is requested to inform the Investigations team by submitting a JCQ M2 Form (downloadable from [www.jcq.org.uk/malpractice](http://www.jcq.org.uk/malpractice)) with supporting documentation to [pqsmalpractice@pearson.com](mailto:pqsmalpractice@pearson.com). Where Pearson receives allegations of malpractice from other sources (for example Pearson staff, anonymous informants), the Investigations team will conduct the investigation directly or may ask the head of centre to assist.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results/certificates while an investigation is in progress. Depending on the outcome of the investigation, results and/or certificates may not be released or they may be withheld.

We reserve the right to withhold certification when undertaking investigations, audits and quality assurance processes. You will be notified within a reasonable period of time if this occurs.

### **3.7.4 Sanctions and appeals**

Where malpractice is proven, we may impose sanctions or penalties, such as:

- mark reduction for affected external assessments
- disqualification from the qualification
- debarment from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures we may impose sanctions such as:

- working with centres to create an improvement action plan
- requiring staff members to receive further training
- placing temporary suspensions on certification of learners
- placing temporary suspensions on registration of learners
- debarring staff members or the centre from delivering Pearson qualifications
- suspending or withdrawing centre approval status.

The centre will be notified if any of these apply.

Pearson has established procedures for centres that are considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from the head of centre (on behalf of learners and/or members or staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in the JCQ Appeals booklet (<https://www.jcq.org.uk/exams-office/appeals>).

## 4 Programme structure

### 4.1 Units, Credits, Total Qualification Time (TQT) and Guided Learning (GL)

The Higher National Certificate (HNC) is a Level 4 qualification made up of 120 credits. It is usually studied full-time over one year, or part-time over two years.

The Higher National Diploma (HND) is a Level 4 and Level 5 qualification made up of 240 credits. It is usually studied full-time over two years, or part-time over four years.

Pearson would expect that an HND student would have achieved at least 90 credits at Level 4 before progressing to Level 5 units. This allows for the students to submit the remaining 30 credits at Level 4 while undertaking their Level 5 study.

Students undertaking an HND who fail to successfully complete the full qualification may be awarded an HNC, if their credit achievement permits.

Pearson BTEC Higher Nationals consist of core units, specialist units and optional units.

- Core units are mandatory.
- Specialist units are designed to provide a specific occupational focus to the qualification and are aligned to professional body and/or higher apprenticeship standards.
- Required combinations of units are clearly set out in the tables below.

Units are usually 15 credits in value, or a multiple thereof. These units have been designed from a learning time perspective, and are expressed in terms of **Total Qualification Time (TQT)**. TQT is an estimate of the total amount of time that could reasonably be expected to be required for a student to achieve and demonstrate the achievement of the level of attainment necessary for the award of a qualification. TQT includes undertaking each of the activities of Guided Learning, Directed Learning and Invigilated Assessment. Each 15-credit unit approximates to a Total Unit Time of 150 hours with 60 hours of Guided Learning.

Total Qualification Time (TQT) for Higher National Certificate (HNC) = 1,200 hours

Total Qualification Time (TQT) for Higher National Diploma (HND) = 2,400 hours

Examples of activities which can contribute to TQT include:

- guided Learning
- independent and unsupervised research/learning
- unsupervised compilation of a portfolio of work experience
- unsupervised e-learning
- unsupervised e-assessment
- unsupervised coursework
- watching a pre-recorded podcast or webinar
- unsupervised work-based learning.

**Guided Learning (GL)** is defined as the time when a tutor is present to give specific guidance towards the learning aim being studied on a programme. This definition includes lectures, tutorials and supervised study in, for example, open learning centres and learning workshops. Guided Learning includes any supervised assessment activity; this includes invigilated examination, observed assessment and observed work-based practice.

Total Guided Learning (GL) for Higher National Certificate (HNC) = 480 hours

Total Guided Learning (GL) for Higher National Diploma (HND) = 960 hours

Some examples of activities which can contribute to GL include:

- classroom-based learning supervised by a tutor
- work-based learning supervised by a tutor
- live webinar or telephone tutorial with a tutor in real time
- e-learning supervised by a tutor in real time
- all forms of assessment which take place under the immediate guidance or supervision of a tutor or other appropriate provider of education or training, including where the assessment is competence-based and may be turned into a learning opportunity.

## 4.2 Programme structures

The programme structures specify:

- the total credit value of the qualification
- the minimum credit to be achieved at the level of the qualification
- the core units
- the specialist mandatory units
- the specialist optional units
- the generic optional units
- the maximum credit value in units that can be centre-commissioned.

When combining units for a Pearson BTEC Higher National qualification, it is the centre's responsibility to make sure that the correct combinations are followed.

### 4.2.1 Pearson BTEC Level 4 Higher National Certificate in Construction

- Qualification credit value: a minimum of 120 credits. This is made up of eight units, each with a value of 15 credits.
- Total Qualification Time (TQT) = 1,200 hours
- Total Guided Learning (GL) = 480 hours
- There is a required mix of core, specialist and optional units totalling 120 credits. All units are at Level 4.
- In some cases, a maximum of 30 credits can be imported from another RQF Pearson BTEC Higher National qualification and/or from units designed by the centre and approved by Pearson. Core units may **not** be substituted and are **mandatory**. For more information please refer to Higher National Commissioned Qualifications.
- Typically, students who may wish to change pathway (in Level 4), may do so following completion of 'core' units; ideally, prior to beginning 'specialist' units.

<b>Pearson BTEC Level 4 Higher National Certificate in Construction (Construction)</b>		<b>Unit credit</b>	<b>Level</b>
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>5 Legal &amp; Statutory Responsibilities in Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>6 Construction Information (Drawing, Detailing, Specification)</b>	15	4
Specialist unit <i>Mandatory</i>	<b>14 Building Information Modelling</b>	15	4
<b>And, a selection of either one 30 credit unit or two 15 credit units from the following list of Optional Units; or, one from the list of Optional Units and one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4
Optional Unit	<b>50 Alternative Sustainable Solutions in Construction</b>	30	4

<b>Pearson BTEC Level 4 Higher National Certificate in Construction (Building Services – Heating, Ventilation and Air Conditioning)</b>		<b>Unit credit</b>	<b>Level</b>
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>8 Mathematics for Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>9 Principles of Heating Services Design &amp; Installation</b>	15	4
Specialist unit <i>Mandatory</i>	<b>10 Principles of Ventilation &amp; Air Conditioning Design &amp; Installation</b>	15	4
Specialist unit <i>Mandatory</i>	<b>48 Scientific Principles for Building Services</b>	15	4
<b>And, one from the following list of Optional Units; or, one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

<b>Pearson BTEC Level 4 Higher National Certificate in Construction (Building Services – Electrical)</b>		<b>Unit credit</b>	<b>Level</b>
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>8 Mathematics for Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>19 Principles of Electrical Design &amp; Installation</b>	15	4
Specialist unit <i>Mandatory</i>	<b>16 Principles of Alternative Energy</b>	15	4
Specialist unit <i>Mandatory</i>	<b>48 Scientific Principles for Building Services</b>	15	4
<b>And, one from the following list of Optional Units; or, one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4



<b>Pearson BTEC Level 4 Higher National Certificate in Construction (Civil Engineering)</b>		<b>Unit credit</b>	<b>Level</b>
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>3 Science &amp; Materials</b>	15	4
Specialist unit <i>Mandatory</i>	<b>6 Construction Information (Drawing, Detailing, Specification)</b>	15	4
Specialist unit <i>Mandatory</i>	<b>8 Mathematics for Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>20 Principles of Structural Design</b>	15	4
<b>And, one from the following list of Optional Units; or, one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

<b>Pearson BTEC Level 4 Higher National Certificate in Construction (Surveying)</b>		<b>Unit credit</b>	<b>Level</b>
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>5 Legal &amp; Statutory Responsibilities in Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>11 Measurement &amp; Estimating</b>	15	4
Specialist unit <i>Mandatory</i>	<b>12 Financial Management &amp; Business Practices in Construction</b>	15	4
<b>And, two from the following list of Optional Units; or, one from the list of Optional Unit and one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

#### 4.2.2 Pearson BTEC Level 5 Higher National Diploma in Construction

- Qualification credit value: a minimum of 240 credits, of which 120 credits are at Level 5, and 120 credits are at Level 4 and usually attained via the HNC.
- There is a required mix of core, specialist and optional units totalling 240 credits. The core unit required for each Level 5 specialist pathway (in addition to the specialist units) is Group Project (Pearson-set), which is weighted at 30 credits.
- The requirements of the Higher National Certificate (or equivalent) have to be met. In some cases, a maximum of 60 credits can be imported from another RQF Pearson BTEC Higher National qualification and/or from units designed by the Centre and approved by Pearson. Core units and specialist units may not be substituted.

The Pearson BTEC Level 5 Higher National Diploma in Construction consists of the Pearson BTEC Level 4 Higher National Certificate (from a defined specialist pathway) plus an additional 120 credits at Level 5 delivered via one of six corresponding specialist pathways. At Level 5, these pathways are:

- Construction – Management
- Construction – Architectural Technology
- Building Services – Electrical
- Building Services – Heating, Ventilation & Air Conditioning
- Civil Engineering
- Surveying

Students will typically progress within the pathways, as shown in *Figure 1* (below). Where a Centre may allow students to change pathways, from Level 4 to Level 5, they must undertake a suitable mapping of accredited prior experience or learning (APEL) in support of any potential review by an External Examiner.

### 4.2.3 Typical Pathway Progression in Pearson BTEC Higher National in Construction

Level	Pathway					
Level 4	Construction		Building Services Engineering (HVAC)	Building Services Engineering (Electrical)	Civil Engineering	Surveying
Level 5	Construction (Management)	Construction (Architectural Technology)	Building Services Engineering (HVAC)	Building Services Engineering (Electrical)	Civil Engineering	Surveying

<b>Pearson BTEC Level 5 Higher National Diploma in Construction (Construction - Management)</b>		<b>Unit credit</b>	<b>Level</b>
<b>Level 4 units:</b>			
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>5 Legal &amp; Statutory Responsibilities in Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>6 Construction Information (Drawing, Detailing, Specification)</b>	15	4
Specialist unit <i>Mandatory</i>	<b>14 Building Information Modelling</b>	15	4
<b>And, a selection of either one 30 credit unit or two 15 credit units from the following list of Optional Units; or, one from the list of Optional Units and one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4
Optional Unit	<b>50 Alternative Sustainable Solutions in Construction</b>	30	4

<b>Level 5 units:</b>			
Core unit <i>Mandatory</i>	<b>22 Group Project (Pearson-set)</b>	30	5
Specialist unit <i>Mandatory</i>	<b>23 Contracts &amp; Management</b>	15	5
Specialist unit <i>Mandatory</i>	<b>24 Project Management</b>	15	5
Specialist unit <i>Mandatory</i>	<b>25 Management for Complex Buildings Projects</b>	15	5
<b>And, three from the list Optional Units; or, two from the list Optional Units and one Specialist Unit another pathway)</b>			
Optional Unit	<b>35 Alternative Methods of Construction</b>	15	5
Optional Unit	<b>36 Advanced Building Information Modelling</b>	15	5
Optional Unit	<b>37 Environmental Assessment &amp; Monitoring</b>	15	5
Optional Unit	<b>38 Personal Professional Development</b>	15	5
Optional Unit	<b>39 Transport Systems for Buildings</b>	15	5
Optional Unit	<b>40 Alternative Energy Systems Design &amp; Installation</b>	15	5
Optional Unit	<b>42 Highway Engineering</b>	15	5
Optional Unit	<b>43 Hydraulics</b>	15	5
Optional Unit	<b>44 Advanced Surveying &amp; Measurement</b>	15	5
Optional Unit	<b>45 Maintenance &amp; Operations</b>	15	5
Optional Unit	<b>46 Advanced Materials</b>	15	5
Optional Unit	<b>47 Construction Data Management</b>	15	5

<b>Pearson BTEC Level 5 Higher National Diploma in Construction (Construction – Architectural Technology)</b>		<b>Unit credit</b>	<b>Level</b>
<b>Level 4 units:</b>			
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>5 Legal &amp; Statutory Responsibilities in Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>6 Construction Information (Drawing, Detailing, Specification)</b>	15	4
Specialist unit <i>Mandatory</i>	<b>14 Building Information Modelling</b>	15	4
<b>And, two from the following list of Optional Units; or, one from the list of Optional Units and one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

<b>Level 5 units:</b>			
Core unit <i>Mandatory</i>	<b>22 Group Project (Pearson-set)</b>	30	5
Specialist unit <i>Mandatory</i>	<b>23 Contracts &amp; Management</b>	15	5
Specialist unit <i>Mandatory</i>	<b>26 Advanced Construction Drawing &amp; Detailing</b>	15	5
Specialist unit <i>Mandatory</i>	<b>27 Construction Technology for Complex Buildings Projects</b>	15	5
<b>And, three Optional Units; or two from the list of Optional Units and one Specialist Unit of any other pathway)</b>			
Optional Unit	<b>35 Alternative Methods of Construction</b>	15	5
Optional Unit	<b>36 Advanced Building Information Modelling</b>	15	5
Optional Unit	<b>37 Environmental Assessment &amp; Monitoring</b>	15	5
Optional Unit	<b>38 Personal Professional Development</b>	15	5
Optional Unit	<b>39 Transport Systems for Buildings</b>	15	5
Optional Unit	<b>40 Alternative Energy Systems Design &amp; Installation</b>	15	5
Optional Unit	<b>42 Highway Engineering</b>	15	5
Optional Unit	<b>43 Hydraulics</b>	15	5
Optional Unit	<b>44 Advanced Surveying &amp; Measurement</b>	15	5
Optional Unit	<b>45 Maintenance &amp; Operations</b>	15	5
Optional Unit	<b>46 Advanced Materials</b>	15	5
Optional Unit	<b>47 Construction Data Management</b>	15	5



<b>Pearson BTEC Level 5 Higher National Diploma in Construction (Building Services – Heating, Ventilation and Air Conditioning)</b>		<b>Unit credit</b>	<b>Level</b>
<b>Level 4 units:</b>			
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>8 Mathematics for Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>9 Principles of Heating Services Design &amp; Installation</b>	15	4
Specialist unit <i>Mandatory</i>	<b>10 Principles of Ventilation &amp; Air Conditioning Design &amp; Installation</b>	15	4
Specialist unit <i>Mandatory</i>	<b>48 Scientific Principles for Building Services</b>	15	4
<b>And, one from the following list of Optional Units; or, one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

<b>Level 5 units:</b>			
Core unit <i>Mandatory</i>	<b>22 Group Project (Pearson-set)</b>	30	5
Specialist unit <i>Mandatory</i>	<b>28 Further Mathematics for Construction</b>	15	5
Specialist unit <i>Mandatory</i>	<b>31 Advanced Heating, Ventilation &amp; Air Conditioning Design &amp; Installation</b>	15	5
Specialist unit <i>Mandatory</i>	<b>49 Thermofluids &amp; Acoustics</b>	15	5
<b>And, three Optional Units; or two from the list of Optional Units and one Specialist Units of any other pathway</b>			
Optional Unit	<b>32 Building Management Systems</b>	15	5
Optional Unit	<b>35 Alternative Methods of Construction</b>	15	5
Optional Unit	<b>36 Advanced Building Information Modelling</b>	15	5
Optional Unit	<b>37 Environmental Assessment &amp; Monitoring</b>	15	5
Optional Unit	<b>38 Personal Professional Development</b>	15	5
Optional Unit	<b>39 Transport Systems in Buildings</b>	15	5
Optional Unit	<b>40 Alternative Energy Systems Design &amp; Installation</b>	15	5
Optional Unit	<b>42 Highway Engineering</b>	15	5
Optional Unit	<b>43 Hydraulics</b>	15	5
Optional Unit	<b>44 Advanced Surveying &amp; Measurement</b>	15	5
Optional Unit	<b>45 Maintenance &amp; Operations</b>	15	5
Optional Unit	<b>46 Advanced Materials</b>	15	5
Optional Unit	<b>47 Construction Data Management</b>	15	5

<b>Pearson BTEC Level 5 Higher National Diploma in Construction (Building Services – Electrical)</b>		<b>Unit credit</b>	<b>Level</b>
<b>Level 4 units:</b>			
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>8 Mathematics for Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>19 Principles of Electrical Design &amp; Installation</b>	15	4
Specialist unit <i>Mandatory</i>	<b>16 Principles of Alternative Energy</b>	15	4
Specialist unit <i>Mandatory</i>	<b>48 Scientific Principles for Building Services</b>	15	4
<b>And, one from the following list of Optional Units; or, one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

<b>Level 5 units:</b>			
Core unit <i>Mandatory</i>	<b>22 Group Project (Pearson-set)</b>	30	5
Specialist unit <i>Mandatory</i>	<b>28 Further Mathematics for Construction</b>	15	5
Specialist unit <i>Mandatory</i>	<b>32 Building Management Systems</b>	15	5
Specialist unit <i>Mandatory</i>	<b>33 Advanced Electrical Design &amp; Installation</b>	15	5
<b>And, three from the list of Optional Units; or, two from the list Optional Unit and one Specialist Unit from another pathway)</b>			
Optional Unit	<b>35 Alternative Methods of Construction</b>	15	5
Optional Unit	<b>36 Advanced Building Information Modelling</b>	15	5
Optional Unit	<b>37 Environmental Assessment &amp; Monitoring</b>	15	5
Optional Unit	<b>38 Personal Professional Development</b>	15	5
Optional Unit	<b>39 Transport Systems in Buildings</b>	15	5
Optional Unit	<b>40 Alternative Energy Systems Design &amp; Installation</b>	15	5
Optional Unit	<b>42 Highway Engineering</b>	15	5
Optional Unit	<b>43 Hydraulics</b>	15	5
Optional Unit	<b>44 Advanced Surveying &amp; Measurement</b>	15	5
Optional Unit	<b>45 Maintenance &amp; Operations</b>	15	5
Optional Unit	<b>46 Advanced Materials</b>	15	5
Optional Unit	<b>47 Construction Data Management</b>	15	5

<b>Pearson BTEC Level 5 Higher National Diploma in Construction (Civil Engineering)</b>		<b>Unit credit</b>	<b>Level</b>
<b>Level 4 units:</b>			
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>3 Science &amp; Materials</b>	15	4
Specialist unit <i>Mandatory</i>	<b>6 Construction Information (Drawing, Detailing, Specification)</b>	15	4
Specialist unit <i>Mandatory</i>	<b>8 Mathematics for Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>20 Principles of Structural Design</b>	15	4
<b>And, one from the following list of Optional Units; or, one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

<b>Level 5 units:</b>			
Core unit <i>Mandatory</i>	<b>22 Group Project (Pearson-set)</b>	30	5
Specialist unit <i>Mandatory</i>	<b>28 Further Mathematics for Construction</b>	15	5
Specialist unit <i>Mandatory</i>	<b>29 Geotechnics &amp; Soil Mechanics</b>	15	5
Specialist unit <i>Mandatory</i>	<b>30 Advanced Structural Design</b>	15	5
<b>And, three from the list Optional Units; or, two from the list of Optional Units and one Specialist Unit from another pathway.</b>			
Optional Unit	<b>35 Alternative Methods of Construction</b>	15	5
Optional Unit	<b>36 Advanced Building Information Modelling</b>	15	5
Optional Unit	<b>37 Environmental Assessment &amp; Monitoring</b>	15	5
Optional Unit	<b>38 Personal Professional Development</b>	15	5
Optional Unit	<b>39 Transport Systems for Buildings</b>	15	5
Optional Unit	<b>40 Alternative Energy Systems Design &amp; Installation</b>	15	5
Optional Unit	<b>42 Highway Engineering</b>	15	5
Optional Unit	<b>43 Hydraulics</b>	15	5
Optional Unit	<b>44 Advanced Surveying &amp; Measurement</b>	15	5
Optional Unit	<b>45 Maintenance &amp; Operations</b>	15	5
Optional Unit	<b>46 Advanced Materials</b>	15	5
Optional Unit	<b>47 Construction Data Management</b>	15	5

<b>Pearson BTEC Level 5 Higher National Diploma in Construction (Surveying)</b>		<b>Unit credit</b>	<b>Level</b>
<b>Level 4 units:</b>			
Core unit <i>Mandatory</i>	<b>1 Individual Project (Pearson-set)</b>	15	4
Core unit <i>Mandatory</i>	<b>2 Construction Technology</b>	15	4
Core unit <i>Mandatory</i>	<b>4 Construction Practice &amp; Management</b>	15	4
Specialist unit <i>Mandatory</i>	<b>5 Legal &amp; Statutory Responsibilities in Construction</b>	15	4
Specialist unit <i>Mandatory</i>	<b>11 Measurement &amp; Estimating</b>	15	4
Specialist unit <i>Mandatory</i>	<b>12 Financial Management &amp; Business Practices in Construction</b>	15	4
<b>And, two from the following list of Optional Units; or, one from the list of Optional Unit and one Specialist Unit from another pathway</b>			
Optional Unit	<b>7 Surveying, Measuring &amp; Setting-out</b>	15	4
Optional Unit	<b>13 Tender &amp; Procurement</b>	15	4
Optional Unit	<b>15 Principles of Refurbishment</b>	15	4
Optional Unit	<b>17 Principles of Public Health Engineering</b>	15	4
Optional Unit	<b>18 Civil Engineering Technology</b>	15	4
Optional Unit	<b>21 Site Supervision &amp; Operations</b>	15	4

<b>Level 5 units:</b>			
Core unit <i>Mandatory</i>	<b>22 Group Project (Pearson-set)</b>	30	5
Specialist unit <i>Mandatory</i>	<b>23 Contracts &amp; Management</b>	15	5
Specialist unit <i>Mandatory</i>	<b>34 Advanced Quantities for Complex Building Projects</b>	15	5
Specialist unit <i>Mandatory</i>	<b>41 Surveying for Conservation, Renovation &amp; Refurbishment</b>	15	5
<b>And, three Optional Units (one Optional Unit may come from Specialist Units of any other pathway)</b>			
Optional Unit	<b>35 Alternative Methods of Construction</b>	15	5
Optional Unit	<b>36 Advanced Building Information Modelling</b>	15	5
Optional Unit	<b>37 Environmental Assessment &amp; Monitoring</b>	15	5
Optional Unit	<b>38 Personal Professional Development</b>	15	5
Optional Unit	<b>39 Transport Systems for Buildings</b>	15	5
Optional Unit	<b>40 Alternative Energy Systems Design &amp; Installation</b>	15	5
Optional Unit	<b>42 Highway Engineering</b>	15	5
Optional Unit	<b>43 Hydraulics</b>	15	5
Optional Unit	<b>44 Advanced Surveying &amp; Measurement</b>	15	5
Optional Unit	<b>45 Maintenance &amp; Operations</b>	15	5
Optional Unit	<b>46 Advanced Materials</b>	15	5
Optional Unit	<b>47 Construction Data Management</b>	15	5



### 4.2.3 Meeting local needs (MLN)

Centres should note that Pearson BTEC Higher National qualifications have been developed in consultation with centres, employers and relevant professional organisations. The units were designed to meet the skill needs of the sector and thereby allow coverage of the full range of employment within the sector. Centres should make maximum use of the choices available to them within the specialist pathways to meet the needs of their students, as well as the local skills and training needs.

Where centres identify a specific need that cannot be addressed using the units in this specification, centres can seek approval to use units from other RQF Pearson BTEC Higher National qualifications, through the MLN process (refer to *Commissioned qualification design and validation service* of our website

<http://qualifications.pearson.com> or get in touch your Pearson regional contact for application details. Centres will need to justify the rationale for importing units from other RQF Pearson BTEC Higher National specifications. **Meeting local need applications must be made in advance of delivery and before 31 January in the year of student registration.**

The flexibility to import standard units from other RQF Pearson BTEC Higher National specifications is **limited to a maximum of 30 credits in a BTEC HNC qualification and a maximum of 60 credits in a BTEC HND qualification (30 credits at Level 4 and 30 credits at Level 5)**. This is an overall maximum of units that can be imported. MLN units cannot be used at the expense of the mandatory units in any qualification nor can the qualification's rules of combination, as detailed in the specification, be compromised. It is the responsibility of the centre requesting the MLN to ensure that approved units are used only in eligible combinations.

For the **Pearson BTEC Level 4 Higher National Certificate in Construction** and **Pearson BTEC Level 5 Higher National Diploma in Construction**, the maximum number of credits that can be imported by pathway are as follows:

Qualification	Pathway	Import at Level 4	Import at Level 5
<b>Pearson BTEC Level 4 Higher National Certificate in Construction</b>	Civil Engineering	15	-
	Construction	30	-
	Building Services – Heating, Ventilation and Air Conditioning	15	-
	Building Services – Electrical	15	-
	Surveying	15	-
<b>Pearson BTEC Level 5 Higher National Diploma in Construction</b>	Construction – Management	30	30
	Construction – Architectural Technology	30	30
	Building Services – Heating, Ventilation and Air Conditioning	15	30
	Building Services – Electrical	15	30
	Civil Engineering	15	30
	Surveying	15	30

#### 4.2.4 Pearson BTEC Higher National Commissioned Development

Where MLN does not provide enough flexibility in terms of qualification structure, centres can request design and development of units by Pearson to meet their specific needs. This is offered by the following types of developments; full commission or partial commission.

We would be pleased to discuss your ideas for a Pearson BTEC Higher National Commissioned Development. For more information please refer to the *Commissioned qualification design and validation service* on our website <http://qualifications.pearson.com>

Once the centre is ready to proceed with a commissioned development, an application must be made, which provides a clear rationale for the development request. Pearson will review the application and may confirm or deny the request. The commissioned unit(s) will be authored by Pearson, in full consultation within the commissioning centre. Applications must be made one year in advance of the first year of commissioned unit(s) delivery.

### 4.3 Pearson-set assignments

There are Pearson-set assignments, as part of core units. Each year, Pearson will issue a *theme* and (for Level 4) a set of related *topics*. Centres will develop an assignment, to be internally assessed, to engage students in work related to the Pearson-set theme.

At Level 4, tutors will select a topic to further define the students' approach to the theme and assignment. At Level 5, it is expected that students will define their own topic, in negotiation with tutors, based on the Pearson-set theme.

For example, from the Pearson BTEC Higher Nationals in Construction:

- Theme: 'Sustainability in the Construction Industry'

Level 4 Topics:

- The impact of material selection on overall project sustainability
- The influence of construction method on project sustainability
- Improving project sustainability through supply chain management
- The role of technology in sustainability; through enhance building performance and monitoring.

Centres can find relevant support in the Pearson-set Assignment Guidance for the units, and the theme and topic release documentation which will be provided for each level.

The aim of the Pearson-set assignments is to provide a common framework for Centres to develop work that will allow cross-sector benchmarking, through the standardisation of student work, and identification and sharing of 'best practice' in higher education teaching and learning. Pearson will share the 'best practice' results with all Centres. For further information about Pearson-set Assignments and assessment, see *section 6* of this document.

## 4.4 The Unit Descriptor

The Unit Descriptor is how we define the individual units of study that make up a Higher National qualification. Students will study and complete the units included in the programme offered at your centre.

We have described each part of the unit, as below. You may refer to any of the Unit Descriptors in *Section 10* of this programme specification.

<b>Unit Title</b>	A broad statement of what the unit will cover.
<b>Unit Code</b>	The Ofqual unit designation
<b>Unit Type</b>	There are three unit types: core (mandatory to all pathways); specialist (mandatory to specific pathways); and optional (available to most pathways)
<b>Unit level</b>	All BTEC Higher National units are at Level 4 or Level 5
<b>Credit value</b>	The credit value is related to total qualification time (TQT) and unit learning hours (ULH), and is easy to calculate. 1 credit is equal to 10 ULH, so 15 credits are equal to 150 ULH. To complete a Higher National Certificate or Diploma students are expected to achieve the appropriate number of credits
<b>Introduction</b>	Some general notes on the unit, setting the scene, stating the purpose, outlining the topics and skills gained on completion of the unit
<b>Learning Outcomes</b>	The Learning Outcomes are explicit statements that clearly express what students will be able to do after the completion of the unit. There are, typically, four Learning Outcomes for each unit.
<b>Essential Content</b>	This section covers the content that students can expect to study as they work towards achieving their Learning Outcomes.

**Learning Outcomes and Assessment Criteria**

Each unit sets out the 'Pass', 'Merit' and 'Distinction' criteria for that unit. When assignments are graded, a tutor will refer to this table, which connects the unit's Learning Outcomes with the student's work. This assignment may be graded at 'Pass', 'Merit' or 'Distinction level, depending on the quality of the students work.

**Recommended Resources**

Lists the resources appropriate to support the study of this unit. This includes books, journals and online material to support learning. The programme tutor may suggest alternatives and additions, usually with a local application or relevance.

## Web resources – referencing:

Some units have web resources as part of their recommended resources lists. Hyperlinking to these resources directly can be problematic as locations and addresses of resources can change over time. To combat this, we have referenced web resources as follows:

- [1] A link to the main page of the website
- [2] The title of the site
- [3] The name of the section or element of the website where the resource can be found
- [4] The type of resource it is, which may be one of the following –
  - o research
  - o general reference
  - o tutorials
  - o training
  - o e-books
  - o report
  - o wiki
  - o article
  - o datasets
  - o development tool
  - o discussion forum

## Web

- |  |  |
|--|--|
| [1] <a href="http://sdfs.db.aist.go.jp">sdfs.db.aist.go.jp</a> | [2] National Institute for Advanced Industrial Science and Technology (AIST) |
|  | [3] Spectral Database for Organic Compounds, SDFS                            |
|  | [4] (General reference)  |
| [1] <a href="http://rsc.org">rsc.org</a>                       | [2] Royal Society of Chemistry   |
|  | [3] Learn Chemistry  |
|  | [4] (General reference)  |

## 5 Teaching and learning

The aim of this section is to provide guidance to centres so that they can engage students in a dynamic, interactive and reflective learning experience. This experience should effectively prepare students to successfully engage in the assessments, which will measure depth, as well as breadth of knowledge. Teaching should stimulate academic engagement, develop challenging yet constructive discourse and encourage students to reflect on their own performance in preparation for a professional career. Additionally, centres are encouraged to expose students to autonomous and independent learning, which will facilitate the development of the academic skills, experiences and techniques required as they progress from one level of study to the next.

Centres are encouraged to develop programmes that have a distinctive focus on entry into work, delivering a curriculum that embeds employability, has a strong commitment to ethics and diversity, and introduces students to contemporary as well as seminal research. All teaching and learning should reflect the expectations of employers and society, and be informed and guided by external benchmarks such as professional and statutory bodies. In so doing, students completing a Pearson BTEC Higher National in Construction will have the attributes, skills, principles and behaviours that will enable them to make a valuable contribution to local, national and international healthcare service provision.

The contributions students make to their own experiences, alongside the experience of their peers, is invaluable. Student engagement and the student voice should form a significant aspect of a student's life. Centres are encouraged to gather student opinions on a range of teaching and learning matters, which would be used to inform and enhance future practice within a programme of study and within a centre.

### 5.1 Delivering quality and depth

A high-quality teaching and learning experience should include qualified and experienced lecturers, an interactive and engaging curriculum, motivated and inspired students, and a support system that caters for the pastoral as well as academic interests of students.

In addition to delivering a quality learning experience, centres must also encourage students to have a deeper understanding of the subject where they are able to go beyond the fundamentals of explaining and describing. Students are expected to show they can analyse data and information, make sense of this and then reach evaluative judgements. At the higher levels of study, there is an expectation that students will be able to apply a degree of criticality to their synthesis of knowledge. This criticality would come from exposure to appropriate and relevant theories, concepts and models.



One of the reasons for delivering a quality learning experience, which has depth as well as breadth, is the benchmarking of the qualification to the Framework for Higher Education Qualifications (FHEQ). It also meets requirements set by the Regulated Qualifications Framework (RQF). The first stage of a Pearson BTEC Higher National in Construction is the Higher National Certificate (HNC), which is aligned with Level 4 of both frameworks, with the Higher National Diploma (HND) aligned with Level 5. This means that the HNC has the same level of demand and expectations as the first year of a degree programme, with the HND having the same level of demand and expectations as the second year of a degree programme.

Centres are expected to provide a broadly similar experience for students to that which they would have if they attended a similar programme at a university. This could mean:

- providing access to library facilities which have, as a minimum, available copies (physically and/or electronically) of all required reading material
- access to research papers and journals
- utilising a virtual learning environment (VLE) to support teaching
- working with local employers (see below) to present real-life case studies
- creating Schemes of Work that embrace a range of teaching and learning techniques
- listening to the student voice.

Irrespective of the type of programme on which a student is enrolled, it is highly advisable that students are inducted onto their Higher National programme. This induction should include an introduction to the course programme and academic study skills that will be essential in supporting their research and studies and, therefore, enhance the learning experience.

An induction programme should consist of the following:

- a course programme overview
- preparing for lessons
- effective engagement in lectures and seminars
- making the most out of the tutor
- assignment requirements
- referencing and plagiarism
- centre policies
- academic study skills.

Pearson offer Higher National Global Study Skills to all students – an online toolkit that supports the delivery, assessment and quality assurance of BTECs in centres. This is available on the HN Global website, [www.highernationals.com](http://www.highernationals.com). HN Global provides a wealth of support to ensure that tutors and students have the best possible experience during their course. With HN Global, students can search, share, comment, rank and sort a vast a vast range of learning resources via an online digital library and tutors can create and annotate reading lists for students.

## 5.2 Engaging with employers

Just as the student voice is important, so too is the employer's. Employers play a significant role in the design and development of all regulated qualifications, including the Higher Nationals in Construction. This input should extend into the learning experience, where engagement with employers will add value to students, particularly in transferring theory into practice. Work placement is an important element of the students' programme and development, and is integrated throughout the qualification. Centres are encouraged to actively engage employers in the delivery and assessment of aspects of the programme as relevant.

Centres should consider a range of employer engagement activities. These could include:

- field trips to local businesses, the industry, research labs
- inviting local Construction employers, specialists, researchers, service users and deliverers to present guest lectures
- using specialists, employers, researchers, to judge the quality of assessed presentations and/or products
- (for the more entrepreneurial) establishing a panel of experts to whom students can present their research and recommendations for service improvement or product development.

While detailed guidance on assessment has been provided in this specification (see *Section 6*), it is worth considering the involvement of employers when determining assessment strategies and the use of different assessment vehicles. This enables centres to design assessments that are more closely related to what students would be doing in the workplace. Employers are able to comment on relevance and content, as well as the challenge presented by an assessment. Notwithstanding this, ultimately it is the centre's responsibility to judge the extent to which any employer contributes to teaching and learning.

### 5.3 Engaging with Professional Bodies

Pearson recognises the importance of Centres having access and support from the profession and the advice those with experience of the industry.

Centres, in planning and delivering their curriculum, are encouraged to engage with the relevant professional bodies. The professional bodies, and their members, may be able to provide support and resources that will enhance the student experience in studying the profession.

Below is a list of professional bodies, associated with the pathways of the Pearson BTEC Higher Nationals in Construction.

Qualification	Pathway
Construction/ Construction Management	Chartered Institute of Buildings (CIOB) British Institute of Facilities Management (BIFM)
Architectural Technology	Chartered Institute of Architectural Technologists (CIAT) Royal Institute of British Architects (RIBA)
Building Services	Chartered Institution of Building Services Engineering (CIBSE) Chartered Institute of Plumbing and Heating Engineering (CIPHE)
Civil Engineering	Chartered Institution of Civil Engineers (ICE) Institution of Structure Engineers (iStructE) Institute of Highway Engineers (IHE) Chartered Institution of Highway and Transportation (CIHT)
Surveying/Quantity Surveying	Royal Institution of Chartered Surveyors (RICS)

While the list above relates to UK professional bodies, many of these are recognised internationally or have regional representation. If you have questions about how a professional body may be able to support your Centre, please contact the organisation or their regional office.

## 5.4 Engaging with students

Students are integral to teaching and learning. As such, it is important that they are involved as much as possible with most aspects of the programme onto which they are enrolled. This input could include taking into account their views on how teaching and learning will take place, their role in helping to design a curriculum, or on the assessment strategy that will test their knowledge and understanding.

There are many ways in which to capture the student voice and student feedback, both formal and informal. Formal mechanisms include the nomination of student representatives to act as the collective student voice for each student cohort, student representation at course team meetings, and an elected Higher Education representative as part of the Student Union. Student forums should also take place periodically throughout the year with minutes and action plans updated and informing the overall annual course monitoring process. Unit-specific feedback can also be collated by students completing unit feedback forms, end-of-year course evaluations, and scheduled performance review meetings with their tutor.

However, this should not be the only time when feedback from students is sought. Discourse with students should be constant, whereby teachers adopt a 'reflection on action' approach to adjust teaching, so that students are presented with an environment that is most supportive of their learning styles. Just as employers could have input into assessment design, so too could students. This will support the development of assignments that are exciting and dynamic, and fully engage students in meaningful and informative assessment.

The biggest advantage of consulting students on their teaching, learning and assessment is securing their engagement in their own learning. Students are likely to feel empowered and develop a sense of ownership of all matters related to teaching, learning and assessment, not just their own experiences. Students could also view themselves as more accountable to their lecturers, ideally seeing themselves as partners in their own learning and not just part of a process.

## 5.5 Planning and structuring a programme

Learning should be challenging yet exciting; teaching should be motivating and inspirational. Consequently, both teaching and learning should form part of a programme structure that is active, flexible and progressive, and has an industry focus wherever possible.

It is important for a programme structure to be effectively planned, taking into account the nature of the student cohort, the primary mode of delivery (face-to-face or distance learning) and the level of study. It is also advisable to consider the student voice (whether that voice is heard through end-of-programme feedback, or through ongoing dialogue) when planning how and when students will be exposed to a particular subject. One other vital source of information that centres would do well to embrace is the feedback from tutors who have been and/or will be delivering learning.

It is recommended that centres establish a programme planning forum where various stakeholders are represented. This forum could consider different perspectives of teaching and learning and how these are planned into an effective programme structure. Consideration could be given to, for example, the holistic and consistent use of Virtual Learning Environments (VLEs), a programme of field trips, a strategy for engaging with employers, and how and when to assess learning.

Consideration should be given to a number of factors when planning a programme structure. These include:

- the sequencing of units (possibly around related units)
- whether to have condensed or expanded delivery
- teaching and learning techniques.

### **5.5.1 Sequencing units**

The level of demand embedded within a unit is benchmarked to recognised standards. This applies to all units within a level of study, and this means that all Level 4 units have similar demands, as do all Level 5 units. However, this does not mean that units can, or should, be delivered in any order. For example, in the Pearson BTEC Higher National Diploma in Construction it is strongly advised that Level 4 units are delivered, and achieved, by students before progression to Level 5. However, students are able to progress to level 5 with a minimum of 90 credits at Level 4.

Within each level it is advisable, in fact the centres are encouraged, to sequence units so that those providing fundamental knowledge and understanding are scheduled early in the programme. It may also be advisable to schedule the assessment of units requiring the practice and application of more advanced skills later in the programme.

### 5.5.2 Condensed, expanded and mixed delivery

The next consideration is whether to deliver a unit in a condensed format alongside other units, or to deliver units over an extended period. The following tables provide examples of this, based on four units being delivered in one teaching block.

#### Condensed version:

Weeks 1 to 6	Week 7	Weeks 8 to 13	Week 14
Unit 1	Assessment	Unit 3	Assessment
Unit 2		Unit 4	

#### Expanded version:

Weeks 1 to 12	Weeks 13 and 14
Unit 1	Assessment
Unit 2	
Unit 3	
Unit 4	

### Mixed version:

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Unit 1													Assessment
Unit 2						Assessment	Unit 3						
Unit 4													

The decision to deliver a condensed, expanded or mixed programme would depend on a number of factors, including availability of resources, when placements are planned, the subjects to be taught and the requirements of students. Each version has advantages: the condensed version would provide an opportunity for students to gain early success and achievement. This will enhance their self-efficacy, sense of belief in their ability to succeed, and self-confidence, with tutors being able to identify and respond to less able students early in the teaching and learning cycle. The advantages of the expanded version include providing a longer timescale for students to absorb new knowledge and, therefore, potentially improve success, and giving tutors an opportunity to coach and support less able students over a longer period of time. The mixed version, with some units spanning over the entire period and others lasting for shorter periods, provides opportunities for learning in some units to support development in others. This format may be particularly suited to a combination of practical and theoretical units. In all cases, the choice of which type of unit sequence must consider student opportunities as well as staff and physical resources of the centre.

As there are pros and cons to all approaches, the use of a planning forum would help to ensure the most suitable approach is taken. For example, centres could choose to deliver the first teaching block using the expanded version, with the subsequent teaching block being delivered through a condensed approach.

It should be noted that the above consideration would apply equally to programmes that are being delivered face-to-face or through distance learning.

### 5.5.3 Drawing on a wide range of delivery techniques

As part of planning the range of delivery techniques that will be used to deliver the syllabus, centres should also consider an appropriate combination of techniques for the subject.

The table below lists, with explanation, some techniques that centres could introduce into a planned programme structure.

Technique	Face-to-face	Distance learning
Lectures and seminars	These are the most common techniques used by tutors. They offer an opportunity to engage with a large number of students, where the focus is on sharing knowledge through the use of presentations.	Delivery would be through video conferencing and/or pre-recorded audio and/or visual material, available through an online platform. Synchronous discussion forums could also be used.
Laboratory Experimentation	Laboratory work focuses on experiential learning of scientific theories in a controlled environment. Experiments are designed to test various scientific theories and establish relationships from the effects that independent variables may have on dependent ones.	Video conferencing would be the primary form of delivery where the students will be observing experiments taking place in laboratories. These would also be supported by pre-recorded material, synchronous discussion forums and analysis of experimental results obtained.
Workshops	These are used to build on knowledge shared via tutors and seminars. Teaching can be more in-depth where knowledge is applied, for example to case studies or real-life examples. Workshops could be student-led, where students present, for example, findings from independent study.	While more challenging to organise than for face-to-face delivery, workshops should not be dismissed. Smaller groups of three or four students could access a forum simultaneously and engage in the same type of activity as for face-to-face.



Technique	Face-to-face	Distance learning
Tutorials	These present an opportunity for focused one-to-one support, where teaching is led by an individual student's requirements. These can be most effective in the run-up to assessment, where tutors can provide more focused direction, perhaps based on a formative assessment.	Other than not necessarily being in the same room as a student, tutors could still provide effective tutorials. Video conferencing tools provide the means to see a student, which makes any conversation more personal.
Virtual Learning Environments (VLEs)	These are invaluable to students studying on a face-to-face programme. Used effectively, VLEs not only provide a repository for taught material such as presentation slides or handouts, but could be used to set formative tasks such as quizzes. Further reading could also be located on a VLE, along with a copy of the programme documents, such as the handbook and assessment timetable.	A VLE is a must if students are engaged with online delivery through distance or blended learning, as this would be the primary or the key source of learning. Where distance learning is primarily delivered through hard copies of workbooks, etc., the same principle would apply as for face-to-face learning.
Blended learning	The combination of traditional face-to-face learning and online learning. This can enable students to gain personalised support, instruction and guidance while completing assigned activities and tasks remotely.	Offline learning enables students to develop autonomy and self-discipline by completing set activities and tasks with limited direction and traditional classroom-based constraints.
Work-based learning	Any opportunity to integrate work-based learning into the curriculum should be taken. This adds realism and provides students with an opportunity to link theory to practice in a way in which case studies do not. Many full-time students are involved in some form of employment, either paid or voluntary, which could be used, where appropriate, as part of their learning e.g. when assignments require students to contextualise a response to a real organisation.	It is likely that the majority of distance learning students would be employed and possibly classed as mature students. Bringing theory to life through a curriculum, which requires work based application of knowledge, would make learning for these students more relevant and meaningful. Perhaps more importantly, assessment should be grounded in a student's place of work, wherever possible.

Technique	Face-to-face	Distance learning
Guest speakers	These could be experts from industry or visiting academics in the subject area that is being studied. They could be used to present a lecture/seminar, a workshop or to contribute to assessment. The objective is to make the most effective use of an expert's knowledge and skill by adding value to the teaching and learning experience.	As long as the expert has access to the same platform as the students then the value-added contribution would still be very high. Consideration would need to be given to timings and logistics, but with some innovative management this technique would still have a place in distance learning programmes.
Field trips	Effectively planned field trips, which have a direct relevance to the syllabus, would add value to the learning experience. Through these trips students could relate theory to practice, have an opportunity to experience organisations in action, and potentially open their minds to career routes.	The use of field trips could be included as part of a distance learning programme. They will add the same value and require the same planning. One additional benefit of field trips for distance learning is that they provide an opportunity for all students in a cohort to meet, which is a rare occurrence for distance-learning students.

#### 5.5.4 Assessment considerations

Centres should design assessment for learning. This is where an assessment strategy requires students to engage with a variety of assessment tools that are accessible, are appropriately challenging, and support the development of student self-efficacy and self-confidence. To ensure that assignments are valid and reliable, centres must implement robust quality assurance measures and monitor the effectiveness of their implementation (see *Section 6*). This includes ensuring that all students engage in assessment positively and honestly.

Assessment also provides a learning opportunity for all stakeholders of the assessment to have access to feedback that is both individual to each student and holistic to the cohort. Feedback to students should be supportive and constructive. Student self-efficacy (and, therefore, self-confidence) can be significantly enhanced where feedback not only focuses on areas for improvement but recognises the strengths a student has. At the cohort level, similar trends could be identified that inform future approaches to assessment and teaching. Assessment is an integral part of the overall learning process and assessment strategy must be developed to support effective, reflective, thinking Construction practitioners for the future. Assessment can be formative, summative or both.

#### 5.5.5 Formative assessment

Formative assessment is primarily developmental in nature and designed to give feedback to students on their performance and progress. It takes place before the summative assessment and as such it does not confirm achievement of grades. Assessment designed formatively should develop and consolidate knowledge, understanding, skills and competencies. It is a key part of the learning process and can enhance learning and contribute to raising standards.

Through formative assessment tutors can identify students' differing learning needs early on in the programme and so make timely corrective interventions. Tutors can also reflect on the results of formative assessment to measure how effective the planned teaching and learning is at delivering the syllabus. Each student should receive one set of written formative feedback, otherwise some students may feel that others are being given more than their share of verbal feedback.

#### 5.5.6 Summative assessment

Summative assessment is where students are provided with the assignment grades contributing towards the overall unit grade. For summative assessment to be effective it should also give students additional feedback to support ongoing development and improvement in subsequent assignments. All formative assessment feeds directly into the summative assessment for each unit and lays the foundations on which students develop the necessary knowledge and skills required for the summative assessment.

### 5.5.7 Assessment feedback

Effective assessment feedback is part of continuous guided learning which promotes learning and enables improvement. It also allows students to reflect on their performance and helps them understand how to make effective use of feedback. Constructive and useful feedback should enable students to understand the strengths and limitations of their performance, providing positive comments where possible as well as explicit comments on how improvements can be made. Feedback should reflect the learning outcomes and assessment criteria to also help students understand how these inform the process of judging the overall grade.

The timing of the provision of feedback and of the returned assessed work also contributes to making feedback effective. Specific turnaround time for feedback should be agreed and communicated with both tutors and students. Timing should allow students the opportunity to reflect on the feedback and consider how to make use of it in forthcoming assessments, taking into account the tutor's workload and ability to provide effective feedback.

### 5.5.8 Designing valid and reliable assessments

To help ensure valid and reliable assignments are designed and are consistent across all units, centres could consider a number of actions.

#### ***Use of language***

The first aspect of an assignment that a centre could focus on is ensuring that language makes tasks/questions more accessible to students.

Due consideration must be given to the command verbs (i.e. the verbs used in unit assessment criteria) when considering the learning outcomes of a unit. Assignments must use appropriate command verbs that equate to the demand of the learning outcome. If the outcome requires 'analysis' then 'evaluative' requirements within the assignment must not be set when testing that outcome. This would be viewed as over-assessing. Similarly, it is possible to under-assess where analytical demands are tested using, for example, explanatory command verbs.

The following can be used as a guide to support assignment design.

- Ensure there is a holistic understanding (by tutors and students) and use of command verbs.
- Set assignment briefs that use a single command verb, focusing on the highest level of demand expected for the learning outcome(s) that is (are) being tested.
- Assignments should be supported by additional guidance that helps students to interpret the demand of the assessment criteria.

- Time-constrained assessments should utilise the full range of command verbs (or acceptable equivalents) appropriate to the academic level. Modes of time-constrained assessments include in-class tests and examinations that could be both open- or closed-book. Centres should pay close consideration to ensuring tests and exams are not replicated during the course of the year.

## **Consistency**

This relates to the consistency of presentation and structure, the consistent use of appropriate assessment language, and the consistent application of grading criteria. Where assignments are consistent, reliability is enhanced. Where validity is present in assignments, this will result in assignments that are fit for purpose and provide a fair and equitable opportunity for all students to engage with the assignment requirements.

## **Employing a range of assessment tools**

Just as variation in teaching methods used is important to the planning of a programme structure, so too is the use of a range of assessment tools appropriate to the unit and its content. Centres should consider taking a holistic view of assessment, ensuring a balanced assessment approach with consideration given to the subject being tested and what is in the best interests of students. As mentioned above, consultation with employers could add a sense of realism to an assessment strategy. (A comprehensive list of assessment tools is provided in *Section 6.2*.)

No matter what tool is used, assignments should have a sector focus (whether this is in a workplace context or through a case study), and be explicitly clear in their instructions. In the absence of a case study, a scenario should be used to provide some context. Finally, students should be clear on the purpose of the assignment and which elements of the unit it is targeting.

## 6 Assessment

Pearson BTEC Higher Nationals in Construction are assessed using a combination of internally assessed **centre-devised internal assignments** (which are set and marked by centres) and internally assessed **Pearson-set assignments** (which are set by Pearson and marked by centres). Pearson-set assignments are mandatory and target particular industry-specific skills. The number and value of these units are dependent on qualification size.

- For the HNC, one core, 15-credit, unit at Level 4 will be assessed by a mandatory Pearson-set assignment targeted at particular skills.
- For the HND, two core units – one core, 15-credit, unit at Level 4 and one core, 30-credit unit at Level 5 – will be assessed by a mandatory Pearson-set assignment targeted at particular skills.

All other units are assessed by centre-devised internal assignments.

The purpose and rationale of having Pearson-set units on Higher Nationals is as follows.

**Standardisation of student work** – Assessing the quality of student work, that it is meeting the level and the requirements of the unit across all centres, that grade decisions and assessor feedback are justified, and that internal verification and moderation processes are picking up any discrepancies and issues.

**Sharing of good practice** – We will share good practice in relation to themes such as innovative approaches to delivery, the use of digital literacy, enhancement of student employability skills and employer engagement. **These themes will align to those for QAA Higher Education Reviews.**

An appointed External Examiner (EE) for the centre will ask to sample the Pearson-set assignment briefs in advance of the external examination visit. Although this is not a mandatory requirement for centres, we strongly advise that centres seek guidance and support from their EE on the Pearson-set assignment. The EE may also include the Pearson-set units in the centre visit sample of student work.

We have taken great care to ensure that the assessment method chosen is appropriate to the content of the unit and in line with requirements from professional bodies, employers and higher education.

In developing an overall plan for delivery and assessment for the programme, you will need to consider the order in which you deliver units, whether delivery will take place over short or long periods of time, and when assessment can take place.

## 6.0.1 Example Assessment Briefs

Each unit has supporting Example Assessment Briefs that are available to download from the course materials section on our website (<http://qualifications.pearson.com>). The Example Assessment Briefs are there to give you an example of what the assessment will look like in terms of the feel and level of demand of the assessment.

The Example Assessment Briefs, with the exception of the mandatory Pearson-set unit, provide tutors with suggested types of assignment and structure that can be adopted and, if so, **must** be adapted accordingly.

## 6.1 Principles of internal assessment

This section gives an overview of the key features of internal assessment and how you, as an approved centre, can offer it effectively. The full requirements and operational information are given in the *Pearson Quality Assurance Handbook* available in the support section of our website (<http://qualifications.pearson.com>). All of the assessment team will need to refer to this document.

For Pearson BTEC Higher Nationals it is important that you can meet the expectations of stakeholders and the needs of students by providing a programme that is practical and applied. Centres can tailor programmes to meet local needs and should use links with local employers and the wider Construction sector.

When internal assessment is operated effectively, it is challenging, engaging, practical and up to date. It must also be fair to all students and meet national standards.

### 6.1.1 Assessment through assignments

For internally assessed units, the format of assessment is an assignment taken after the content of the unit, or part of the unit if several assignments are used, has been fully delivered. An assignment may take a variety of forms, including practical and written types. An assignment is a distinct activity completed independently by students (either alone or in a team). An assignment is separate from teaching, practice, exploration and other activities that students complete with direction from, and formative assessment by, tutors.

An assignment is issued to students as an **assignment brief** with a hand-out date, a completion date and clear requirements for the evidence that students are expected to provide. There may be specific observed practical components during the assignment period. Assignments can be divided into separate parts and may require several forms of evidence. A valid assignment will enable a clear and formal assessment outcome based on the assessment criteria.

### 6.1.2 Assessment decisions through applying unit-based criteria

Assessment decisions for Pearson BTEC Higher Nationals are based on the specific criteria given in each unit and set at each grade level. The criteria for each unit have been defined according to a framework to ensure that standards are consistent in the qualification and across the suite as a whole. The way in which individual units are written provides a balance of assessment of understanding, practical skills and career-related attributes appropriate to the purpose of the qualifications.

The assessment criteria for a unit are hierarchical and holistic. For example, if an M criterion requires the student to show 'analysis' and the related P criterion requires the student to 'explain', then to satisfy the M criterion a student will need to cover both 'explain' and 'analyse'. The unit assessment grid shows the relationships among the criteria so that assessors can apply all the criteria to the student's evidence at the same time. In *Appendix 3* we have set out a definition of terms that assessors need to understand.

Assessors must show how they have reached their decisions using the criteria in the assessment records. When a student has completed all the assessment for a unit then the assessment team will give a grade for the unit. This is given simply according to the highest level for which the student is judged to have met all the criteria. Therefore:

- **To achieve a Pass**, a student must have satisfied all the Pass criteria for the learning outcomes, showing coverage of the unit content and, therefore, attainment at Level 4 or 5 of the National Framework.
- **To achieve a Merit**, a student must have satisfied all the Merit criteria (and, therefore, all of the Pass criteria) through high performance in each learning outcome.
- **To achieve a Distinction**, a student must have satisfied all the Distinction criteria (and, therefore, all of the Pass and Merit criteria), and these define outstanding performance across the unit as a whole.

The award of a Pass is a defined level of performance and cannot be given solely on the basis of a student completing assignments. Students who do not satisfy the Pass criteria should be reported as Unclassified.

### 6.1.3 The assessment team

It is important that there is an effective team for internal assessment. There are three key roles involved in implementing assessment processes in your centre, each with different interrelated responsibilities, and these roles are listed below. Full information is given in the *Pearson Quality Assurance Handbook* available in the support section of our website (<http://qualifications.pearson.com>).



- **The Programme Leader** has overall responsibility for the programme, its assessment and internal verification to meet our requirements, record-keeping and liaison with the External Examiner. The Programme Leader registers annually with Pearson and acts as an assessor, supports the rest of the assessment team, makes sure they have the information they need about our assessment requirements, and organises training, making use of our guidance and support materials.
- **Internal Verifiers** (IVs) oversee all assessment activity in consultation with the Programme Leader. They check that assignments and assessment decisions are valid and that they meet our requirements. IVs will be standardised by working with the Programme Leader. Normally, IVs are also assessors, but they do not verify their own assessments.
- **Assessors** set or use assignments to assess students to national standards. Before taking any assessment decisions, assessors participate in standardisation activities led by the Programme Leader. They work with the Programme Leader and IVs to ensure that the assessment is planned and carried out in line with our requirements. Placement assessments must be carried out by appropriately qualified assessors.
- Your **External Examiner** (EE) will sample student work across assessors. Your EE will also want to see evidence of internal verification of assignments and assessed decisions.

#### 6.1.4 Effective organisation

Internal assessment needs to be well organised so that student progress can be tracked and so that we can monitor that assessment is being carried out in line with national standards. We support you in this through, for example, providing training materials and sample documentation. Our online HN Global service can also help support you in planning and record-keeping.

It is particularly important that you manage the overall assignment programme and deadlines to make sure that all your students are able to complete assignments on time.

#### 6.1.5 Student preparation

To ensure that you provide effective assessment for your students, you need to make sure that they understand their responsibilities for assessment and the centre's arrangements. From induction onwards, you will want to ensure that students are motivated to work consistently and independently to achieve the requirements of the qualifications. They need to understand how assignments are used, the importance of meeting assignment deadlines, and that all the work submitted for assessment must be their own.

You will need to give your students a guide that explains:

- how assignments are used for assessment
- how assignments relate to the teaching programme
- how they should use and reference source materials, including what would constitute plagiarism.

The guide should also set out your Centre's approach to operating assessments, such as how students must submit assignments/work and the consequences of submitting late work, and the procedure for requesting extensions for mitigating circumstances.

## **6.2 Setting effective assessments**

### **6.2.1 Setting the number and structure of assessments**

In setting your assessments you need to work with the structure of assessments shown in the relevant section of a unit. This shows the learning aims and outcomes and the criteria that you are expected to follow.

Pearson provide online Example Assessment Briefs for each unit to support you in developing and designing your own assessments.

In designing your own assignment briefs you should bear in mind the following points.

- The number of assignments for a unit must not exceed the number of learning outcomes listed in the unit descriptor. However, you may choose to combine assignments, either to cover a number of learning outcomes or to create a single assignment for the entire unit.
- You may also choose to combine all or parts of different units into single assignments, provided that all units and all their associated learning outcomes are fully addressed in the programme overall. If you choose to take this approach you need to make sure that students are fully prepared, so that they can provide all the required evidence for assessment, and that you are able to track achievement in assessment records.
- A learning outcome must always be assessed as a whole and must not be split into two or more elements.
- The assignment must be targeted to the learning outcomes but the learning outcomes and their associated criteria are not tasks in themselves. Criteria are expressed in terms of the outcome shown in the evidence.

- Some units may be suited to an exam-based or time-constrained assessment approach, to appropriately prepare students for further study; such as progression onto level 6 programmes or to meet professional recognition requirements. Example Assessment Briefs are available for examples of exam-based assessments. Units where this approach may be suitable include:
  - Unit 8: Mathematics for Construction
  - Unit 19: Principles of Electrical Design & Installation
  - Unit 20: Principles of Structural Design
  - Unit 28: Further Mathematics for Construction
  - Unit 30: Advanced Structural Design
  - Unit 33: Advanced Electrical Design & Installation
  - Unit 40: Alternative Energy Systems Design & Installation
  - Unit 43: Hydraulics
  - Unit 48: Scientific Principles for Building Services
  - Unit 49: Thermofluids & Acoustics

You do not have to follow the order of the learning outcomes of a unit in setting assignments, but later learning outcomes often require students to apply the content of earlier learning outcomes, and they may require students to draw their learning together.

Assignments must be structured to allow students to demonstrate the full range of achievement at all grade levels. Students need to be treated fairly by being given the opportunity to achieve a higher grade, if they have the ability.

As assignments provide a final assessment, they will draw on the specified range of teaching content for the learning outcomes. **The specified unit content must be taught/delivered.** The evidence for assessment need not cover every aspect of the teaching content, as students will normally be given particular examples, case studies or contexts in their assignments. For example, if a student is carrying out one practical performance, or an investigation of one organisation, then they will address all the relevant range of content that applies in that instance.

## 6.2.2 Providing an assignment brief

A good assignment brief is one that, through providing challenging and authentic sector/work-related tasks, motivates students to provide appropriate evidence of what they have learned.

An assignment brief should have:

- a career-related scenario; this could be a simple situation or a full, detailed set of career-related requirements that motivates the student to apply their learning through the assignment
- clear instructions to the student about what they are required to do, normally set out through a series of tasks
- an audience or purpose for which the evidence is being provided
- an explanation of how the assignment relates to the unit(s) being assessed.

### 6.2.3 Forms of evidence

Pearson BTEC Higher Nationals have always allowed for a variety of forms of assessment evidence to be used, provided they are suited to the type of learning outcomes being assessed. For many units, the practical demonstration of skills is necessary and, for others, students will need to carry out their own research and analysis, working independently or as part of a team.

The Example Assessment Briefs give you information on what would be suitable forms of evidence to give students the opportunity to apply a range of employability or transferable skills. Centres may choose to use different suitable forms of evidence to those proposed. Overall, students should be assessed using varied forms of evidence.

These are some of the main types of assessment:

- written reports, essays
- in-class tests or examinations
- creation of planning documents
- work-based projects and portfolios
- academic posters, displays, leaflets
- slide presentations
- recordings of interviews/role plays
- work placement logbooks and reflective journals
- workplace observation of practice and assessment records
- presentations with assessor questioning
- professional discussions
- time-constrained assessment.

(Full definitions of different types of assessment are given in *Appendix 4*.)

The form(s) of evidence selected must:

- allow the student to provide all the evidence required for the learning outcomes and the associated assessment criteria at all grade levels
- allow the student to produce evidence that is their own independent work
- allow a verifier to independently reassess the student to check the assessor's decisions.

For example, when you are using performance evidence, you need to think about how supporting evidence can be captured through recordings, photographs or task sheets.

Centres need to take particular care that students are enabled to produce independent work. For example, if students are asked to use real examples, then best practice would be to encourage them to use examples of their own or to give the group a number of examples that can be used in varied combinations.

## **6.3 Making valid assessment decisions**

### **6.3.1 Authenticity of student work**

An assessor must assess only student work that is authentic, i.e. students' own independent work. Students must authenticate the evidence that they provide for assessment through signing a declaration stating that it is their own work. A student declaration must state that:

- evidence submitted for that assignment is the student's own
- the student understands that false declaration is a form of malpractice.

Assessors must ensure that evidence is authentic to a student through setting valid assignments and supervising them during the assessment period. Assessors must also take care not to provide direct input, instructions or specific feedback that may compromise authenticity.

Centres may use Pearson templates or their own templates to document authentication.

During assessment an assessor may suspect that some or all of the evidence from a student is not authentic. The assessor must then take appropriate action, using the centre's policies for malpractice. (See *section 3.7* in this Programme Specification for further information.)

### **6.3.2 Making assessment decisions using criteria**

Assessors make judgements using the criteria. The evidence from a student can be judged using all the relevant criteria at the same time. The assessor needs to make a judgement against each criterion that evidence is present and sufficiently comprehensive. For example, the inclusion of a concluding section may be insufficient to satisfy a criterion requiring 'evaluation'.

Assessors should use the following information and support in reaching assessment decisions:

- the explanation of key terms in *Appendix 3* of this document
- examples of verified assessed work
- your Programme Leader and assessment team's collective experience.

### **6.3.3 Dealing with late completion of assignments**

Students must have a clear understanding of the centre's policy on completing assignments by the deadlines that you give them. Students may be given authorised extensions for legitimate reasons, such as illness, at the time of submission, in line with your centre's policies (see also *Section 3.6*).

For assessment to be fair, it is important that students are all assessed in the same way and that some students are not advantaged by having additional time or the opportunity to learn from others. Centres should develop and publish their own regulations on late submission; this should make clear the relationship between late submission and the centre's mitigating circumstances policy.

Centres may apply a penalty to assignments that are submitted beyond the published deadline. However, if a late submission is accepted, then the assignment should be assessed normally, when it is submitted, using the relevant assessment criteria, with any penalty or cap applied after the assessment. Where the result of assessment may be capped, due to late submission of the assignment, the student should be given an indication of their uncapped grade, in order to recognise the learning that has been achieved, and assessment feedback should be provided in relation to the uncapped achievement.

As with all assessment results, both the uncapped and capped grades should be recorded and ratified by an appropriate assessment board, taking into account any mitigating circumstances that may have been submitted.

### **6.3.4 Issuing assessment decisions and feedback**

Once the assessment team has completed the assessment process for an assignment, the outcome is a formal assessment decision. This is recorded and reported to students. The information given to the student:

- must show the formal decision and how it has been reached, indicating how or where criteria have been met
- may show why attainment against criteria has not been demonstrated
- must not provide feedback on how to improve evidence but can suggest how to improve in the future.

### 6.3.5 Resubmission opportunity

An assignment provides the final assessment for the relevant learning outcomes, and is normally a final assessment decision. A student who, for the first assessment opportunity, has failed to achieve a Pass for that unit specification **shall be expected to undertake a reassessment**.

- Only one opportunity for reassessment of the unit will be permitted.
- Reassessment for coursework, project or portfolio-based assessments shall normally involve the reworking of the original task.
- For examinations, reassessment shall involve completion of a new task.
- A student who undertakes a reassessment will have their grade capped at a Pass for that unit.
- A student will not be entitled to be reassessed in any component of assessment for which a Pass grade or higher has already been awarded.

### 6.3.6 Repeat Units

In cases of students who, for the first assessment opportunity and resubmission opportunity, still fail to achieve a Pass for that unit specification:

- at the discretion of the centre and Assessment Board, decisions can be made to permit a repeat of a unit
- the student must study the unit again with full attendance and payment of the unit fee
- the overall unit grade for a successfully completed repeat unit is capped at a Pass for that unit
- units can be repeated only once.

### 6.3.7 Assessment Boards

Each centre is expected by Pearson to hold Assessment Boards for all of its BTEC Higher National programmes. The main purpose of an Assessment Board is to make recommendations on:

- the grades achieved by students on the individual units
- extenuating circumstances
- cases of cheating and plagiarism
- progression of students on to the next stage of the programme
- the awards to be made to students
- referrals and deferrals.

Assessment Boards may also monitor academic standards. The main boards are normally held at the end of the session, although if your centre operates on a semester system there may be (intermediate) boards at the end of the first semester. There may also be separate boards to deal with referrals.

Where a centre does not currently have such a process then the External Examiner (EE) should discuss this with the Quality Nominee and Programme Leader, stressing the requirement for Assessment Boards by both Pearson and QAA, and that Assessment Board reports and minutes provide valuable evidence for QAA's Review of College Higher Education process.

## 6.4 Planning and record keeping

For internal processes to be effective, an assessment team needs to be well organised and keep effective records. The centre will also work closely with us so that we can quality assure that national standards are being satisfied. This process gives stakeholders confidence in the assessment approach.

The Programme Leader should have an assessment plan. When producing a plan, the assessment team will wish to consider:

- the time required for training and standardisation of the assessment team
- the time available to undertake teaching and carrying out of assessment, taking account of when students may complete external assessments and when quality assurance will take place
- the completion dates for different assignments
- who is acting as Internal Verifier (IV) for each assignment, and the date by which the assignment needs to be verified
- setting an approach to sampling assessor decisions through internal verification that covers all assignments, assessors and a range of students
- how to manage the assessment and verification of students' work, so that they can be given formal decisions promptly
- how resubmission opportunities can be scheduled.

The Programme Leader will also maintain records of assessment undertaken. The key records are:

- Verification of assignment briefs
- Student authentication declarations
- Assessor decisions on assignments, with feedback given to students
- Verification of assessment decisions.

Examples of records and further information are available in the *Pearson Quality Assurance Handbook* available in the support section of our website (<http://qualifications.pearson.com>).



## 6.5 Calculation of the final qualification grade

### 6.5.1 Conditions for the award

#### Conditions for the award of the HND

To achieve a Pearson BTEC Level 5 Higher National Diploma qualification a student must have:

- completed units equivalent to 120 credits at level 5
- achieved at least a pass in 105 credits at level 5
- completed units equivalent to 120 credits at level 4
- achieved at least a pass in 105 credits at level 4.

#### Conditions for the award of the HNC

To achieve a Pearson BTEC Level 4 Higher National Certificate qualification a student must have:

- completed units equivalent to 120 credits at level 4
- achieved at least a pass in 105 credits at level 4.

### 6.5.2 Compensation provisions

#### Compensation provisions for the HND

Students can still be awarded an HND if they have attempted but not achieved a Pass in one of the 15-credit units completed at level 4, and similarly if they have attempted but not achieved a Pass in one of the 15-credit units at level 5. However, they must complete and pass the remaining units for an HNC or HND as per the unit rules of combination of the required qualification.

#### Compensation provisions for the HNC

Students can still be awarded an HNC if they have attempted but not achieved a Pass in one of the 15-credit units completed, but have completed and passed the remaining units.

### 6.5.3 Calculation of the overall qualification grade

The calculation of the **overall qualification grade** is based on the student's performance in all units. Students are awarded a Pass, Merit or Distinction qualification grade, using the points gained through all 120 credits, at Level 4 for the HNC or Level 5 for the HND, based on unit achievement. The overall qualification grade is calculated in the same way for the HNC and for the HND.

All units in valid combination must have been attempted for each qualification. The conditions of award and the compensation provisions will apply as outlined above. All 120 credits count in calculating the grade (at each level, as applicable).

The overall qualification grade for the HND will be calculated based on student performance in Level 5 units only.

Units that have been attempted but not achieved, and subsequently granted compensation, will appear as 'Unclassified', i.e. a 'U' grade, on the student's Notification of Performance, that is issued with the student certificate.

### Points per credit

Grade	Points
Pass	4
Merit	6
Distinction	8

### Point boundaries

Grade	Point boundaries
Pass	420–599
Merit	600–839
Distinction	840 +

## 6.5.4 Modelled student outcomes

### Pearson BTEC Level 4 Higher National Certificate

				STUDENT 1		STUDENT 2		STUDENT 3		STUDENT 4		STUDENT 5	
	Credits	Level	Grade point	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points
Core 1	15	4	4	P	60	P	60	P	60	D	120	D	120
Core 2	15	4	4	P	60	P	60	P	60	D	120	M	90
Core 3	15	4	4	P	60	P	60	P	60	D	120	M	90
Core 4	15	4	4	P	60	P	60	M	90	M	90	M	90
Core 5	15	4	6	M	90	P	60	M	90	M	90	M	90
Core 6	15	4	6	M	90	P	60	M	90	M	90	M	90
Opt 1	15	4	6	M	90	M	90	D	120	D	120	D	120
Opt 2	15	4	6	M	90	M	90	D	120	D	120	D	120
TOTAL	120				600		540		690		870		810
GRADE					M		P		M		D		M

### Pearson BTEC Level 5 Higher National Diploma

				STUDENT 1		STUDENT 2		STUDENT 3		STUDENT 4		STUDENT 5	
	Credits	Level	Grade point	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points
Core 1	15	4	0	P	0	P	0	P	0	D	0	P	0
Core 2	15	4	0	P	0	P	0	P	0	D	0	M	0
Core 3	15	4	0	P	0	P	0	P	0	D	0	M	0
Core 4	15	4	0	P	0	P	0	M	0	M	0	M	0
Core 5	15	4	0	M	0	P	0	M	0	M	0	P	0
Core 6	15	4	0	M	0	P	0	M	0	D	0	U	0
Opt 1	15	4	0	M	0	P	0	D	0	D	0	D	0
Opt 2	15	4	0	M	0	P	0	D	0	D	0	D	0
Core 7	30	5	6	M	180	M	180	M	180	P	120	D	240
Core 8	15	5	6	M	90	M	90	M	90	P	60	D	120
Opt 3	15	5	6	M	90	M	90	D	120	P	60	D	120
Opt 4	15	5	6	M	90	P	60	D	120	P	60	D	120
Opt 5	15	5	6	M	90	P	60	D	120	M	90	M	90
Opt 6	15	5	6	M	90	P	60	M	90	M	90	P	60
Opt 7	15	5	6	M	90	P	60	M	90	M	90	M	90
TOTAL	240				720		600		810		570		840
GRADE					M		M		M		P		D

## 7 Quality assurance

Pearson's quality assurance system for all Pearson BTEC Higher National programmes is benchmarked to Level 4 and Level 5 on the UK Quality Assurance Agency's (QAA) Framework for Higher Education Qualifications (FHEQ). This will ensure that centres have effective quality assurance processes to review programme delivery. It will also ensure that the outcomes of assessment are to national standards.

The quality assurance process for centres offering Pearson BTEC Higher National programmes comprises five key components:

- 1 The approval process
- 2 Monitoring of internal centre systems
- 3 Independent assessment review
- 4 Annual programme monitoring report
- 5 Annual student survey

### 7.1 The approval process

Centres new to the delivery of Pearson programmes will be required to seek approval through the centre approval process that includes the programme approval process (refer to '*Becoming a centre*' section on our website <http://qualifications.pearson.com>). Programme approval for centres new to Higher Nationals are only considered in one way:

- desk-based approval review
- review and approval visit to the centre.

Prior to approval being given, centres will be required to submit documentary evidence to demonstrate that they:

- have the human and physical resources required for effective delivery and assessment
- understand the implications for independent assessment and agree to abide by these
- have a robust internal assessment system supported by 'fit-for-purpose' assessment documentation
- have a system to internally verify assessment decisions, to ensure standardised assessment decisions are made across all assessors and sites.

Applications for approval must be supported by the head of the centre (Principal or Chief Executive, etc.) and include a declaration that the centre will operate the programmes strictly, as approved and in line with Pearson requirements.

Centres seeking to renew their programme approval upon expiry of their current approval period may be eligible for the automatic approval process (refer to *Pearson BTEC Higher National Approval Guidance 2019* available at <http://qualifications.pearson.com>), subject to the centre meeting the eligibility criteria set out by Pearson.

Regardless of the type of centre, Pearson reserves the right to withdraw either qualification or centre approval when it deems there is an irreversible breakdown in the centre's ability to quality assure either its programme delivery or its assessment standards.

## **7.2 Monitoring of internal centre systems**

Centres will be required to demonstrate ongoing fulfilment of the centre approval criteria over time and across all Higher National programmes. The review of these systems are either done through a Quality Management Review or and Academic Management Review (QMR or AMR) in the UK or by your External Examiner for international centres. Centres will be given the opportunity to present evidence of the ongoing suitability and deployment of their systems to carry out the required functions. This includes the consistent application of policies affecting student registrations, appeals, effective internal examination and standardisation processes. Where appropriate, centres may present evidence of their operation within a recognised code of practice, such as that of the '*UK Quality Assurance Agency for Higher Education quality code*' (refer to [www.qaa.ac.uk/quality-code](http://www.qaa.ac.uk/quality-code)). Pearson reserves the right to confirm independently that these arrangements are operating to Pearson's standards.

Pearson will affirm, or not, the ongoing effectiveness of such systems. Where system failures are identified, sanctions (appropriate to the nature of the problem) will be applied, in order to assist the centre in correcting the problem.

### **7.2.1 External Examiners**

External Examiners ensure that Centres are meeting appropriate standards. They are appointed by Pearson and are not members of the programme and assessment team. Their role is essentially that of a moderator, they do not mark work but moderate the decisions made by Internal Verifiers.

They have the right to attend Assessment Boards and are also able to act in an advisory capacity.

External Examination performs the same quality checks as other forms of standards verification. It also ensures that the processes and procedures you have in place are consistent and appropriate for qualifications at higher and professional levels.

Where appropriate, Pearson will seek to appoint External Examiners who have professional and/or academic experience within the subject area for which they will be examining. In addition, Pearson will prioritise the appointment of External Examiners who are members of the relevant professional bodies associated with their area of examination. This would typically mean:

Pathway	Professional Body Membership
Civil Engineering	Institution of Civil Engineers (ICE) Institution of Structure Engineers (iStructE) Chartered Institution of Highways and Transportation (CIHT) Institute of Highway Engineers (IHE)
Building Services Engineering	Chartered Institution of Building Services Engineers (CIBSE) Chartered Institute of Plumbing and Heating Engineering (CIPHE)
Construction Management	Chartered Institute of Buildings (CIOB)
Architectural Technology	Chartered Institute of Architectural Technologists (CIAT)
Surveying	Royal Institution of Chartered Surveyors (RICS)

### 7.3 Independent assessment review

The internal assessment outcomes reached for all Pearson BTEC Higher National programmes benchmarked to Level 4 and Level 5 of the Quality Assurance Agency (QAA) Framework for Higher Education Qualifications (FHEQ) are subject to a visit from a Pearson-appointed External Examiner (known as Standards Verifiers for lower level BTEC programmes). The outcomes of this process will be:

- to confirm that internal assessment is to UK national standards and allow certification, **or**
- to make recommendations to improve the quality of assessment outcomes before certification is released, **or**
- to make recommendations about the centre's ability to continue to be approved for the Pearson BTEC Higher National qualifications in question.

## 7.4 Annual Programme Monitoring Report (APMR)

The APMR is a strategic overview of a centre's Higher National programmes which is written that provides an opportunity for centres to analyse and reflect on the most recent teaching year. By working in collaboration with centres, the information can be used by Pearson to further enhance the quality assurance of the Pearson BTEC Higher National programmes. An overview report is produced to outline the findings of the APMR each year. This can be accessed on HigherNationals.com at <http://monitoring-report.highernationals.com>.

## 7.5 Annual student survey

Pearson will conduct an annual survey of Pearson BTEC Higher National students. The purpose of the survey is to enable Pearson to gain a snapshot of every Higher National student's experience as part of the quality assurance process, by engaging with students studying on these programmes. Each centre that has sufficient students engage with the survey will get their own bespoke report about their results. The report can be accessed on HN Global at <http://hnglobal.highernationals.com>

## 7.6 Centre and qualification approval

As part of the approval process, your centre must make sure that the resource requirements listed below are in place before offering the qualification.

Centres must have appropriate physical resources (for example equipment, IT, learning materials, teaching rooms) to support the delivery and assessment of the qualifications.

- Staff involved in the assessment process must have relevant expertise and/or occupational experience.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification.
- Centres must have in place appropriate health and safety policies relating to the use of equipment by staff and students.
- Centres must deliver the qualification in accordance with current equality legislation.
- Centres should refer to the individual unit descriptors to check for any specific resources required.

The result, we believe, is qualifications that will meet the needs and expectations of students worldwide.

## 7.7 Continuing quality assurance and standards verification

We produce annually the latest version of the Pearson Quality Assurance Handbook, available in the support section of our website (<http://qualifications.pearson.com>). It contains detailed guidance on the quality processes required to underpin robust assessment and internal verification.

The key principles of quality assurance are that:

- a centre delivering Pearson BTEC Higher National programmes must be an approved centre, and must have approval for the programmes or groups of programmes that it is delivering
- the centre agrees, as part of gaining approval, to abide by specific terms and conditions around the effective delivery and quality assurance of assessment; it must abide by these conditions throughout the period of delivery
- Pearson makes available to approved centres a range of materials and opportunities through the assessment checking service. This is intended to exemplify the processes required for effective assessment and provide examples of effective standards. Approved centres must use the materials and services to ensure that all staff delivering BTEC qualifications keep up to date with the guidance on assessment
- an approved centre must follow agreed protocols for standardisation of assessors and verifiers, for the planning, monitoring and recording of assessment processes, and for dealing with special circumstances, appeals and malpractice.

The approach of quality-assured assessment is through a partnership between an approved centre and Pearson. We will make sure that each centre follows best practice and employs appropriate technology to support quality assurance processes where practicable. We work to support centres and seek to make sure that our quality-assurance processes do not place undue bureaucratic processes on centres. We monitor and support centres in the effective operation of assessment and quality assurance.

The methods we use to do this for Pearson BTEC Higher Nationals include:

- making sure that all centres complete appropriate declarations at the time of approval
- undertaking approval visits to centres
- making sure that centres have effective teams of assessors and verifiers who are trained to undertake assessment
- assessment sampling and verification through requested samples of assessments, completed assessed student work and associated documentation
- an overarching review and assessment of a centre's strategy for assessing and quality-assuring its BTEC programmes.



An approved centre must make certification claims only when authorised by us and strictly in accordance with requirements for reporting. Centres that do not fully address and maintain rigorous approaches to quality assurance cannot seek certification for individual programmes or for all Pearson BTEC Higher National qualifications.

Centres that do not comply with remedial action plans may have their approval to deliver qualifications removed.

## 8 Recognition of Prior Learning and attainment

Recognition of Prior Learning (RPL) is a method of assessment (leading to the award of credit) that considers whether students can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess, and so do not need to develop through a course of learning.

Pearson encourages Centres to recognise students' previous achievements and experiences whether at work, home or at leisure, as well as in the classroom. RPL provides a route for the recognition of the achievements resulting from continuous learning. RPL enables recognition of achievement from a range of activities using any valid assessment methodology. Provided that the assessment requirements of a given unit or qualification have been met, the use of RPL is acceptable for accrediting a unit, units or a whole qualification. Evidence of learning must be valid and reliable.

For full guidance on RPL please refer to the *Recognition of Prior Learning* policy document available in the support section of our website (<https://qualifications.pearson.com>).

QCF Pearson BTEC Level 4 Higher National Certificate in Construction in the Built Environment unit content mapped to the Level 4 units available in the RQF Pearson BTEC Higher National in Construction is available in *Appendix 8*.

## 9 Equality and diversity

Equality and fairness are central to our work. The design of these qualifications embeds consideration of equality and diversity as set out in the qualification regulators' General Conditions of Recognition. Promoting equality and diversity involves treating everyone with equal dignity and worth, while also raising aspirations and supporting achievement for people with diverse requirements, entitlements and backgrounds. An inclusive environment for learning anticipates the varied requirements of students, and aims to ensure that all students have equal access to educational opportunities. Equality of opportunity involves enabling access for people who have differing individual requirements as well as eliminating arbitrary and unnecessary barriers to learning. In addition, students with and without disabilities are offered learning opportunities that are equally accessible to them, by means of inclusive qualification design.

Pearson's equality policy requires all students to have equal opportunity to access our qualifications and assessments. It also requires our qualifications to be designed and awarded in a way that is fair to every student. We are committed to making sure that:

- Students with a protected characteristic (as defined in legislation) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic.
- All students achieve the recognition they deserve from undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Pearson's policy regarding access to its qualifications is that:

- They should be available to everyone who is capable of reaching the required standards
- They should be free from any barriers that restrict access and progression
- There should be equal opportunities for all those wishing to access the qualifications.

Centres are required to recruit students to Higher National qualifications with integrity. This will include ensuring that applicants have appropriate information and advice about the qualifications, and that the qualification will meet their needs. Centres will need to review the entry profile of qualifications and/or experience held by applicants, considering whether this profile shows an ability to progress to a higher-level qualification. Centres should take appropriate steps to assess each applicant's potential and make a professional judgement about their ability to successfully complete the programme of study and achieve the qualification. This assessment will need to take account of the support available to the student within the centre during their programme of study and any specific support that might be necessary to allow the student to access the assessment for the qualification. Centres should consult our policy documents on students with particular requirements.

### **Access to qualifications for students with disabilities or specific needs**

Students taking a qualification may be assessed in a **recognised regional sign language**, where it is permitted for the purpose of reasonable adjustments. Further information on access arrangements can be found in the Joint Council for Qualifications (JCQ) document Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational Qualifications. Details on how to make adjustments for students with protected characteristics are given in the document Pearson Supplementary Guidance for Reasonable Adjustment and Special Consideration in Vocational Internally Assessed Units. See the support section of our website for both documents (<http://qualifications.pearson.com/>).

# 10 Pearson BTEC Higher Nationals in Construction Units

# Unit 1: Individual Project (Pearson-set)

<b>Unit code</b>	<b>R/615/1387</b>
<b>Unit type</b>	<b>Core</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The ability to define, plan and undertake a project is a critical set of skills needed in various roles within the construction industry. Identifying appropriate information and analysing this, to formulate clear results or recommendations, is required to underpin many of the processes that inform construction projects.

The aim of this unit is to support students in using and applying the knowledge and skills they have developed through other areas of their studies to complete and present an individual project. In addition, this unit will provide students with key study skills that will support them in further study.

Students will be able to identify, define, plan, develop and execute a successful project by working through a clear process. They will develop a project brief; outlining a problem that requires a solution, as well as a project specification, the specific requirements of which the final outcome must meet. They will research the problem, undertaking a feasibility study, and consider a range of potential solutions using critical analysis and evaluation techniques to test, select and contextualise their preferred solution. Students will provide a work and time management plan, keeping a diary of all activities, reflecting on their process and their learning throughout the project.

**\*Please refer to the accompanying Pearson-set Assignment Guide and the Theme Release document for further support and guidance on the delivery of the Pearson-set unit.**

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Formulate a project that will provide a solution to an identified problem
- 2 Manage a project within agreed timescales and specification; documenting the process throughout
- 3 Evaluate potential project management solutions
- 4 Produce a project report and deliver a presentation of the final project outcomes.

## Essential Content

### LO1 **Formulate a project that will provide a solution to an identified problem**

*Project identification*

*Research methods*

*Feasibility studies*

*Brief and specification*

### LO2 **Manage a project within agreed timescales and specification, documenting the process throughout**

*Resources and resource planning*

*Costs and cost planning*

*Work plan:*

Gantt charts

Project Evaluation and Review Technique (PERT) charts

Critical Path Method (CPM).

*Project tracking:*

Progress tracking

Milestones.

### LO3 **Evaluate potential project management solutions**

*PERT analysis*

*CPM analysis*

### LO4 **Produce a project report and deliver a presentation of the final project outcomes**

*Report formats*

*Presentation techniques.*



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Formulate a project that will provide a solution to an identified problem		<b>LO1 and LO2</b>  <b>D1</b> Evaluate the relationship between project identification, feasibility and project planning, with consideration of the impact of project scope on time and resources
<b>P1</b> Select an appropriate construction-based project, giving reasons for your choice  <b>P2</b> Identify the main components of a project specification	<b>M1</b> Explain why the project specification is of fundamental importance to a successful project outcome	
<b>LO2</b> Manage a project within agreed timescales and specification, documenting the process throughout		
<b>P3</b> Identify potential resources, costs and timescales  <b>P4</b> Describe a range of appropriate techniques for generating realistic potential solutions	<b>M2</b> Prepare and update a project management plan, using standard systems of time and resource tracking	

Pass	Merit	Distinction
<b>LO3</b> Evaluate potential project management solutions		<b>LO3 and LO4</b> <b>D2</b> Appraise your own performance in managing the project; draw conclusions and make recommendations that would further improve your performance in the future
<b>P5</b> Explore project management strategies to determine suitability for a given project <b>P6</b> Justify the selection of your preferred solution, making reference to your initial project specification	<b>M3</b> Compare the outcomes of your initial planned resources, timescales and costs against actual outcomes	
<b>LO4</b> Produce a project report and deliver a presentation of the final project outcomes		
<b>P7</b> Produce a written report identifying each stage of the project <b>P8</b> Utilise appropriate forms of referencing and citation in the preparation of a written report <b>P9</b> Prepare a presentation of your final project outcomes, utilising industry standard software	<b>M4</b> Present your final project outcomes and recommendations to a selected audience	

## Recommended Resources

### Textbooks

BALDWIN, A. (2014) *Handbook for Construction Planning and Scheduling*. London: Wiley-Blackwell.

BUSSEY, P. (2015) *CDM 2015: A Practical Guide for Architects and Designers*. London: RIBA.

CIOB (2010) *Guide to Good Practice in the Management of Time in Complex Projects*. London: Chartered Institute of Building.

GOETSCH, D.L. (2011) *Construction Safety & Health*. London: Pearson.

KELLY, J. and MALE, S. (1992) *Value Management in Design and Construction: The Economic Management of Project*. London: Taylor & Francis.

LAWSON, B. (2005) *How Designers Think: The Design Process Demystified*. London: Routledge.

POTTS, K. and ANKRAH, N. (2014) *Construction Cost Management: Learning from Case Studies*. London: Routledge.

WYATT, D. (2007) *Construction Specifications: Principles and Applications*. New York: Delmar.

### Links

This unit links to the following related units:

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

## Unit 2: Construction Technology

<b>Unit code</b>	<b>Y/615/1388</b>
<b>Unit type</b>	<b>Core</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The basic principles of construction technology have not changed for hundreds of years. However, the materials and techniques used to achieve these basic principles are constantly evolving; to enable the construction industry to deliver better quality buildings. Scarcity of resources and the continuing demand of more sophisticated clients, end users and other stakeholder interests, are driving the construction industry to provide buildings which facilitate enhanced environmental and energy performance, and greater flexibility, in response to ever increasing financial, environmental, legal and economic constraints.

This unit will introduce the different technological concepts used to enable the construction of building elements; from substructure to completion, by understanding the different functional characteristics and design considerations to be borne in mind when selecting the most suitable technological solution.

Topics included in this unit are: substructure, superstructure, finishes, building services and infrastructure components. On successful completion of this unit a student will be able to analyse scenarios and select the most appropriate construction technology solution.

## Learning Outcomes

By the end of this unit, a student will be able to:

- 1 Explain the terminology used in construction technology
- 2 Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria
- 3 Identify the different types of civil engineering/infrastructure technology used in support of buildings
- 4 Illustrate the supply and distribution of a range of building services and how they are accommodated within the building.

## Essential Content

### LO1 Explain the terminology used in construction technology

#### *Types of construction activity:*

Low, medium and high-rise buildings, domestic buildings, for example house, flats and other multi-occupancy buildings, commercial buildings, for example offices and shops, industrial buildings, for example, light industrial and warehouses.

#### *Construction technology terminology:*

Loadbearing and non-loadbearing, structural stability, movement and thermal expansion, durability, weather and moisture resistance, aesthetics, fire resistance, sound insulation, resistance to heat loss and thermal transmission, dimensional co-ordination and standardisation, sustainability and scarcity of availability, on-site and off-site construction, legal requirements, buildability, health & safety.

#### *Construction information:*

Drawings, specification, schedules, CAD, Building Information Modelling (BIM).

#### *Sustainability:*

Supply chain

Lifecycle

'Cradle-to-grave'

'Cradle-to-cradle'

Circular economies.

**LO2 Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria**

*Pre-design studies:*

Desk-top, Site Reconnaissance, Direct Soil Investigation techniques.

*Substructure functions and design considerations:*

Different methods for gathering disturbed and undisturbed samples, influence of soil type on foundation design, including water and chemical content, potential loads, position of trees and the impact on foundations, economic considerations, legal considerations (health & safety work in excavations), building regulations, plant requirements.

*Types of foundations:*

Shallow and deep foundations, strip and deep strip foundations, pad foundations, raft foundations, piled foundations (replacement and displacement piles).

*Types of superstructure:*

Traditional construction, framed construction: steel, composite concrete and steel, timber.

Walls; roofs; structural frames; claddings; finishes; services.

*Walls:*

External walls: traditional cavity, timber frame, lightweight steel.

Cladding: panel systems, infill systems, composite panel systems, internal partition walls.

*Roofs:*

Pitched and flat roof systems, roof coverings.

*Floors:*

Ground floors, intermediate floors, floor finishes.

*Staircases:*

Timber, concrete, metal staircases, means of escape.

*Finishes:*

Ceiling, wall and floor finishes.

**LO3 Identify the different types of civil engineering/infrastructure technology used in support of buildings**

*Site remediation and de-watering:*

Contamination management: cut-off techniques, encapsulation.

Soil remediation: stone piling, vibro-compaction.

De-watering: permanent sheet piling, secant piling, grout injection freezing, temporary techniques, such as pumping, wells, electro-osmosis.

*Substructure works:*

Basement construction: steel sheet piling, concrete diaphragm walls, coffer dams, caissons, culverts.

*Superstructure works:*

Reinforced concrete work: formwork, reinforcement, fabrication, concrete, steel.

**LO4 Illustrate the supply and distribution of a range of building services and how they are accommodated within the building**

*Primary service supply*

Cold water

Gas

Electricity.

*Services distribution*

Hot and cold water

Single-phase and 3-phase electricity

Air conditioning ductwork.

*Services accommodation:*

Raised access flooring

Suspended ceilings

Partitioning

Rising ducts.



## Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
<b>L01</b> Explain the terminology used in construction technology			
<p><b>P1</b> Describe the differences between residential, commercial and industrial buildings</p> <p><b>P2</b> Explain how the functional characteristics and design selection criteria are informed by proposed building use</p> <p><b>P3</b> Discuss the ways in which sustainability can be promoted in building projects</p>	<p><b>M1</b> Apply the terminology used in construction technology to a given building construction project</p>	<p><b>D1</b> Evaluate how the functional characteristics and design selection criteria impact on the eventual design solution</p>	
<b>L02</b> Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria			
<p><b>P4</b> Describe the pre-design studies carried out and types of information collected for a given construction site</p> <p><b>P5</b> Explain the functional characteristics and design criteria for primary and secondary elements of a building substructure and superstructure</p>	<p><b>M2</b> Analyse how site conditions impact on the design of foundations</p> <p><b>M3</b> Illustrate how the component parts of an element allow it to fulfil its function</p>	<p><b>L02 and L03</b></p> <p><b>D2</b> Prepare a design report identifying superstructure, substructure and civil engineering structures necessary for a given building construction project</p>	
<b>L03</b> Identify the different types of civil engineering/ infrastructure technology used in support of buildings			
<p><b>P6</b> Describe techniques used for remediating the site prior to construction commencing</p> <p><b>P7</b> Describe the types of substructure works carried out by civil engineers</p>	<p><b>M4</b> Compare different types of structural frame used to carry the primary and secondary elements of the superstructure</p>		

Pass	Merit	Distinction
<p><b>LO4</b> Illustrate the supply and distribution of a range of building services and how they are accommodated within the building.</p>		<p><b>D3</b> Appraise how the distribution of the primary services impact on the overall design of the building</p>
<p><b>P8</b> Describe the supply arrangements for primary services</p> <p><b>P9</b> Explain the distribution arrangements for primary services</p>	<p><b>M5</b> Demonstrate the elements of the superstructure used to facilitate the primary services</p>	

## Recommended Resources

### Textbooks

BRYAN, T. (2010) *Construction Technology: Analysis and Choice*, Oxford: Blackwell.

CHARTLETT, A. and MAYBERY-THOMAS, C. (2013) *Fundamental Building Technology*. 3rd ed. Abingdon: Routledge.

CHUDLEY, R. et al. (2012) *Advanced Construction Technology*. 5th ed. Harlow: Pearson Education Limited.

CHUDLEY, R. and GRENNO, R. (2016) *Building Construction Handbook*. Abingdon: Routledge.

FLEMING, E. (2005) *Construction Technology: An Illustrated Introduction*. Oxford: Blackwell.

### Links

This unit links to the following related units:

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawings, Detailing, Specification)*

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 14: Building Information Modelling*

*Unit 15: Principles of Refurbishment*

*Unit 18: Civil Engineering Technology*

*Unit 25: Management for Complex Building Projects*

*Unit 27: Construction Technology for Complex Building Projects*

*Unit 35: Alternative Methods of Construction*

*Unit 46: Advanced Materials*

## Unit 3: Science & Materials

<b>Unit code</b>	<b>D/615/1389</b>
<b>Unit type</b>	<b>Core</b>
<b>Credit value</b>	<b>15</b>

### Introduction

Science and material performance are intrinsically linked through the need to create structures and spaces that perform in both mechanical operation and in providing human comfort.

This unit aims to support students to make material choices to achieve the desired outcomes of a brief. This is approached from the perspective of materials being fit for purpose; as defined by testing standards and properties, but also by consideration of the environmental impact and sustainability. Awareness of Health & Safety is considered alongside the need to meet legislative requirements.

The topics covered in this unit include: Health & Safety; storage and use of materials; handling, and problems associated with misuse and unprotected use; environmental and sustainable consideration in material choices; and human comfort performance parameters. Material choice is developed through the understanding of testing procedures to establish conformity to standards and define performance properties. The performance of materials to satisfy regulations and provide appropriate comfort levels is addressed through design and calculations.

Upon successful completion of this unit students will be able to make informed decisions regarding material choices; based on understanding the structural behaviour of materials established through recognised testing methods, sustainability, context of build, and Health & Safety. Students will also be able to perform the calculations necessary to establish anticipated performance of the materials in-use and therefore determine their compliance with regulations and suitability.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Review health & safety regulations and legislation associated with the storage, handling and use of materials on a construction site
- 2 Discuss the environmental and sustainability factors which can impact on and influence the material choices for a construction project
- 3 Present material choices for a given building using performance properties, experimental data, sustainability and environmental consideration
- 4 Evaluate the performance of a given building in respect of its human comfort requirements.

## Essential Content

### LO1 **Review health & safety regulations and legislation associated with the storage, handling and use of materials on a construction site**

#### *Regulations and guidance:*

Health & safety management regulations

Design management regulations

Provision and use of equipment regulations

Control and management of hazardous materials through storage, movement and use.

#### *Materials handling and installation:*

Risk assessments and method statements (qualitative and quantitative)

Materials storage: moving materials safely; working in confined spaces; working at height

Occupational health risks associated with materials: asbestos-related and respiratory disease; dermatitis and skin problems; musculoskeletal disorders; hand arm vibration

Personal Protective Equipment (PPE).

### LO2 **Discuss the environmental and sustainability factors which can impact and influence the material choices for a construction project**

#### *Environmental considerations:*

Lifecycle assessment

Environmental profile methodology

Environmental product declaration and certification

Embodied energy

Waste management: the economics and technologies of construction waste disposal.

#### *Sustainability:*

Resource availability and depletion: renewable and non-renewable materials

Reuse and recycling of construction and demolition waste

Waste and Resources Action Programme (WRAP).

*Environmental assessment methods:*

Building Research Establishment Environmental Assessment Method (BREEAM)

Leadership in Energy and Environmental Design (LEED)

Green Star

Estidama, or other forms of environmental assessment

Construction Industry Research Information Association.

**LO3 Present material choices for a given building using performance properties, experimental data, sustainability and environmental consideration**

*Material testing:*

Testing methods, interpreting test data

Codes and standards.

*Structural behaviours*

Performance properties: strength, elasticity, toughness, hardness, creep, fatigue, porosity, brittleness, density, thermal conductivity, durability

Inherent material properties.

*Relationship between material properties, behaviour and use*

**LO4 Evaluate the performance of a given building in respect of its human comfort requirements**

*Human comfort provision:*

Indoor environmental quality: thermal, illumination, sound, ventilation

Thermal losses and gains

Passive and active design: design solutions, environmental benefit vs implementation cost

Calculations of u-values, lux levels, acoustic and ventilation.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Review health &amp; safety regulations and legislation associated with the storage, handling and use of materials on a construction site</p>		<p><b>D1</b> Discuss how multiple regulations and legislation would apply to a given site activity, highlighting how to plan and manage for safe handling and use</p>
<p><b>P1</b> Explain how regulations impact on the use, storage and handling of a selection of vocationally typical construction materials</p>	<p><b>M1</b> Assess how risk assessments can be used to address significant hazards posed by selected materials or activities</p>	
<p><b>LO2</b> Discuss the environmental and sustainability factors which impact on and influence the material choices for a construction project</p>		<p><b>LO2 and LO3</b></p> <p><b>D2</b> Illustrate how the use of sustainable practices and considerations for material choice can improve the environmental rating of the completed building</p>
<p><b>P2</b> Explain material environmental profiling and lifecycle assessment Use a relevant material to exemplify your explanation</p> <p><b>P3</b> Discuss the benefits of product declaration and environmental certification</p>	<p><b>M2</b> Produce a waste management plan for a given project, taking into account a typical range of relevant waste materials</p>	
<p><b>LO3</b> Present material choices for a given building using performance properties, experimental data, sustainability and environmental consideration</p>		
<p><b>P4</b> Present the results of relevant testing procedures to identify performance characteristics of selected construction materials</p> <p><b>P5</b> Discuss the results in terms of the material properties and regulatory requirements, highlighting any unexpected results and why these may occur</p> <p><b>P6</b> Select construction materials for a given building based upon their performance properties in use</p>	<p><b>M3</b> Assess the effects of loading structural materials and compare the behaviours and performance of materials which could be used for the same function</p>	



Pass	Merit	Distinction
<p><b>LO4</b> Evaluate the performance of a given building in respect of its human comfort requirements.</p>		<p><b>D3</b> Evaluate how the use of passive or active strategies can minimise energy, materials, water, and land use</p>
<p><b>P7</b> Define a material selection strategy with regard to human comfort requirements</p> <p><b>P8</b> Identify materials for a selected area within a building and explain how these contribute to a balanced indoor environment</p>	<p><b>M4</b> Perform calculations which relate to a selected area (lux levels, u-values, acoustic and ventilation)</p>	

## Recommended Resources

### Textbooks

- BLANC, A. (2014) *Internal Components*. Abingdon: Routledge.
- BUXTON, P. (2015) *Metric Handbook: Planning and Design Data*. Abingdon: Routledge.
- CASINI, M. (2016) *Smart Buildings: Advanced Materials and Nanotechnology to Improve Energy*. Duxford: Woodhead Publishing.
- CLAISSE, P.A. (2015) *Civil Engineering Materials*. Kidlington: Butterworth-Heinemann.
- DEAN, Y. (1996) *Materials Technology* (Mitchells Building Series). Abingdon: Routledge.
- DORAN, D. and CATHER, B. (2013) *Construction Materials Reference Book*. Abingdon: Routledge.
- EVERETT, A. (1994) *Materials. (Mitchells Building Series)*. 5th ed. Abingdon: Routledge.
- KATIB, J.M. (2009) *Sustainability of Construction Materials*. Abingdon: Woodhead Publishing Ltd.
- LYONS, A. (2014) *Materials for Architects and Builders*. 5th ed. Abingdon: Routledge.
- PACHECO-TORGA, F. and JALALI, S. (2011) *Eco-Efficient Construction and Building Materials*. London: Springer.
- PACHECO-TORGA, F. et al. (2013) *Eco-efficient Construction and Building Materials, Life Cycle Assessment (LCA), Eco-Labeling and Case Studies*. London: Springer.
- THOMAS, R. (ed.) (2006) *Environmental design: An Introduction for Architects and Engineers*. 3rd ed. London: Taylor & Francis.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 15: Principles of Refurbishment*

*Unit 16: Principles of Alternative Energy*

*Unit 35: Alternative Methods of Construction*

*Unit 46: Advanced Materials*

# Unit 4: Construction Practice & Management

<b>Unit code</b>	<b>R/615/1390</b>
<b>Unit type</b>	<b>Core</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The aim of this unit is to develop and provide students with a holistic understanding of construction practice and management processes. Students will investigate and research the modern construction industry, both from the practical skills embedded within the industry through to its linkage with development on-site and the connection with construction management; including roles within the industry.

The unit compares and investigates small, medium and large construction companies within the market place and how construction processes, for development, have evolved.

Students will also explore how Health & Safety has evolved within the industry, including how the major stakeholders, from companies to site operatives, have embedded Health & Safety into their preferred areas of development and careers. In addition, students will explore Building Information Modelling and how it fits into construction processes/sequences ranging from domestic to large-scale and design and build projects.

The knowledge from this unit will provide students with an understanding of modern construction and management; the skills, management of people and projects, and how Health & Safety have changed the perception of the construction industry.

## Learning Outcomes

By the end of this unit, a student will be able to:

- 1 Describe the construction industry with reference to company structures and other activities
- 2 Explain different types of construction companies in the market and their relationships within the tendering process
- 3 Discuss the key stages in a construction project, and how Building Information Modelling informs the different stages
- 4 Analyse how the construction industry has developed suitable collaboration strategies in support of greater recognition of Health & Safety.

## Essential Content

### LO1 Describe the construction industry with reference to company structures and other activities

*Understanding of the construction industry:*

Historical development of the construction industry

Professional and other institutes, including societies

Links between professional, technical and skills professionals

Contractor and head office structure

Site structure and organisation

Types of contractual work tendered by companies.

### LO2 Explain different types of construction companies in the market and their relationships within the tendering process

*Company types:*

Professional relationships between companies

Contract tendering

Tender process.

### LO3 Discuss the key stages in a construction project, and how Building Information Modelling informs the different stages

*Master programmes and contract planning techniques*

*The role of Building Information Modelling (BIM) on the construction*

*Modern procurement methods within construction*

*Sustainability*

**LO4 Analyse how the construction industry has developed suitable collaboration strategies in support of greater recognition of Health & Safety**

*Key stakeholders in the construction process*

*BIM and collaboration*

*Health & safety within the construction industry:*

Pre-construction regulations and legislation

Site safety.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Describe the construction industry with reference to company structures and other activities		<b>D1</b> Critically evaluate how construction companies have developed their structure and business ethos
<b>P1</b> Explain how the construction industry has developed and encompassed professionalism within its structures  <b>P2</b> Demonstrate the scope and linkage between all parties within a construction organisation  <b>P3</b> Identify the type of contractual work tendered by contractors	<b>M1</b> Analyse how the construction industry has developed overall in terms of company structures, it's employees and contracted work	
<b>LO2</b> Explain different types of construction companies within the market and their relationships within the tendering process		<b>D2</b> Compare the factors that influence contract relationships between different organisations involved in tendering.
<b>P4</b> Identify the different types of construction companies in the market  <b>P5</b> Explain the relationship between different construction organisations	<b>M2</b> Analyse the relationships between construction companies through contracts and tendering.	

Pass	Merit	Distinction
<p><b>LO3</b> Discuss the key stages in a construction project, and how Building Information Modelling informs the different stages</p>		<p><b>D3</b> Provide a detailed analysis of how the construction industry has evolved in terms of innovative construction methods and contracts</p>
<p><b>P6</b> Identify, with examples, modern construction processes and sequences used within today's industry, highlighting the way they respond to sustainability needs</p> <p><b>P7</b> Explain contract planning techniques used within micro and macro projects</p> <p><b>P8</b> Identify where BIM impacts upon operations and construction companies</p>	<p><b>M3</b> Analyse how construction has developed in terms of innovation, designs, and within contracts for micro and macro projects, and the interrelationship with BIM</p>	
<p><b>LO4</b> Analyse how the construction industry has developed suitable collaboration strategies in support of greater recognition of Health &amp; Safety.</p>		<p><b>D4</b> Evaluate the impact of Health &amp; Safety legislation, how it has evolved the drivers for it, and its advantages or weaknesses within construction</p>
<p><b>P9</b> Explain how Health &amp; Safety has now become an integrated part of the construction process</p> <p><b>P10</b> Describe the government legislation which has benchmarked Health &amp; Safety within construction</p> <p><b>P11</b> Discuss the role of collaboration and communication in ensuring safe working practices</p>	<p><b>M4</b> Demonstrate how the construction industry has benefited through changes in Health &amp; Safety legislation</p>	



## Recommended Resources

### Textbooks

GRIFFITH, A. and WATSON, P. (2003) *Construction Management: Principles and Practice*. Hampshire: Palgrave Macmillan.

HARRIS, F. and MCCAFFER, R. (2013) *Modern Construction Management*. Chichester: Wiley-Blackwell.

KYMMELL, W. (2007) *Building Information Modelling: Planning and Managing Construction Projects*. New York: McGraw Hill Professional.

OTTOSSON, H. (2012) *Practical Project Management for Building and Construction*. Boca Raton: CRC Press.

### Websites

[www.ciob.org.uk](http://www.ciob.org.uk)

Chartered Institute of Building  
(General Reference)

[www.rics.org](http://www.rics.org)

Royal Institute of Chartered Surveyors  
(General Reference)

### Links

This unit links to the following related units:

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 13: Tender & Procurement*

*Unit 23: Contracts & Management*

*Unit 24: Project Management*

*Unit 25: Management for Complex Building Projects*

*Unit 38: Personal Professional Development*

*Unit 45: Maintenance & Operations*

*Unit 47: Construction Data Management*

# Unit 5: Legal & Statutory Responsibilities in Construction

<b>Unit code</b>	<b>Y/615/1391</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The construction industry is perceived to be a dangerous, noisy and disruptive area of work which impacts on the use of land and buildings. It is, however, governed by a range of areas of law to ensure that professionals; such as architects, quantity surveyors and contractors, comply with legal and statutory requirements to design, construct and deliver buildings and alterations using safe working practices and utilising land appropriately.

This unit will introduce the different areas of law that are relevant to the construction industry throughout the development process. This includes applying for planning approval to undertake construction activities and using building control regulations to evaluate building design and alterations at the preconstruction stage. The unit will explore the laws of occupiers' liability, trespass and nuisance to manage construction activities on-site, and the legal aspects of the sale and leasing process involved in the disposal of buildings; using the law of contract and land law.

Topics included in this unit are: planning law, building control regulations, insurance, the law of tort and the law of contract and land law.

On successful completion of this unit students will be able to apply legal and statutory requirements and processes common to the construction sector.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Examine the process used to obtain planning permission for the construction and alteration of buildings
- 2 Discuss the processes and regulations used to control design and to ensure safe buildings
- 3 Assess the laws used to ensure that construction sites operate safely and consider adjoining land-users
- 4 Analyse how the law of contract and land law are used to sell and lease land and buildings.

## Essential Content

### LO1 **Examine the process used to obtain planning permission for the construction and alteration of buildings**

#### *Gaining planning permission:*

The legal framework, legislation and regulatory agencies involved in applying for planning permission

Types of development and types of permitted development where approval is not required

Stages and requirements of the application process, including statutory and public notification requirements

Approval process and conditions.

#### *Appealing planning decisions:*

The right of appeal open to applicants and the general public, and legal timeframes for appeal

The stages in planning appeal processes, and procedures and notification periods.

#### *Planning enforcement:*

Notification processes and procedures

Right of appeal and timeframes.

### LO2 **Discuss the processes and regulations used to control design and to ensure safe buildings**

#### *Building control systems:*

History and development.

Legal framework, legislation and regulatory agencies.

#### *Requirements of building control and regulations:*

Building regulation standards and areas of jurisdiction

Obtaining approval and right of appeal processes

Approvals, inspection and compliance

Enforcement and dangerous buildings.

### LO3 **Assess the laws used to ensure that construction sites operate safely and consider adjoining land-users**

#### *Administration of the law:*

Courts, personnel, sources of law, including legislation and case law, speciality courts and alternative dispute resolution methods.

#### *Occupiers' liability:*

Duty of care, breach of duty, damage, defences, dangerous premises, visitors, children, independent contractors, trespassers and non-visitors, case law and legislation.

#### *Vicarious liability:*

Recognising who is an employer and an employee and application of the course of employment rule.

Independent contractors, general principles and non-delegable duties.

#### *Trespass to land:*

Intrusion, possession, defences, remedies, including damages, injunction and ejection

The operation of the construction industry and trespass

Mitigating measures and the Considerate Contractors Scheme.

#### *Nuisance:*

Private nuisance, including interference, unlawfulness, impact of continuity, sensitivity and locality, liability, defences and remedies

Public nuisance, including the operation of the construction industry, nuisance mitigating measures and the Considerate Contractors Scheme.

#### *Insurance:*

Types of insurance, including public liability insurance

Employers' liability insurance

Contractors' All Risks insurance

Latent Defects insurance

Machinery insurance

Personal accident insurance and contract bonds.

**LO4 Analyse how the law of contract and land law are used to sell and lease land and buildings**

*History and development of land ownership:*

Types of land ownership and registration of ownership

Tenure restrictions on ownership, including restrictive covenants and easements.

*Law of contract and property conveyancing:*

Key stages in the law of contract, including offer, intention, capacity and consideration

The stages and requirements of the property conveyancing process.

*Landlord and tenant law:*

Legislation, construction and types of leases

Lease terms and conditions, rent and repair responsibilities and management of other agreed terms

Terminating and ending a lease

Lease disputes and mediation processes.

*Construction activity and party and boundary walls:*

Types of wall, including party walls, party structures, boundary and retaining walls

Key legislation, regulations and case law

Trespass and nuisance considerations

Procedures and obligations on neighbour notification and agreement.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Examine the process used to obtain planning permission for the construction and alteration of buildings		<b>LO1 and LO2</b>  <b>D1</b> Evaluate the impact of planning systems and building regulations agencies in managing the development of land and buildings
<b>P1</b> Explain the key legislation and agencies in the planning process  <b>P2</b> Explain how planning decisions are made and processes available to appeal and monitor them	<b>M1</b> Analyse the role of planning systems and agencies in managing the development of land and buildings	
<b>LO2</b> Discuss the processes and regulations used to control design and to ensure safe buildings		
<b>P3</b> Explain the key legislation and agencies in the building control process  <b>P4</b> Discuss how building decisions are determined and the processes available to appeal and monitor them	<b>M2</b> Analyse the application of building regulations in low and medium rise residential and commercial buildings.	

Pass	Merit	Distinction
<p><b>LO3</b> Assess the laws used to ensure that construction sites operate safely and consider adjoining land-users</p>		<p><b>D2</b> Design a detailed plan for a contractor to reduce the legal impacts of a large urban construction project</p>
<p><b>P5</b> Explain how the law of trespass and nuisance relate to the construction industry</p> <p><b>P6</b> Discuss how the laws of occupiers' liability and vicarious liability apply to the construction industry</p>	<p><b>M3</b> Produce a plan for a contractor to manage the legal impacts of a large urban construction project</p>	
<p><b>LO4</b> Analyse how the law of contract and land law are used to sell and lease land and buildings.</p>		<p><b>D3</b> Assess the impact of land law and property law in the development and disposal of a large urban construction project</p>
<p><b>P7</b> Analyse how land law has evolved to shape modern land ownership and the role of contract law in buying and selling property</p> <p><b>P8</b> Discuss how landlord and tenant law is used to manage property</p>	<p><b>M4</b> Evaluate how the application of land law and landlord and tenant law control the disposal and use of property</p>	



## Recommended Resources

### Textbooks

CARD, R., MURDOCH, J. and MURDOCH, S. (2011) *Real Estate Management Law*. 7th ed. Oxford: Oxford University Press.

CLOUGH, R.H., SEARS, G.A., SEARS, K.S., SEGNER, R.O. and ROUNDS, J.L. (2015) *Construction Contracting: A Practical Guide to Company Management*. 8th ed. Hoboken: John Wiley & Sons.

MASON, J. (2016) *Construction Law: From Beginner to Practitioner*. London: Routledge.

UFF, J. (2013) *Construction Law*. London: Sweet & Maxwell.

### Links

This unit links to the following related units:

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 13: Tender & Procurement*

*Unit 14: Building Information Modelling*

*Unit 23: Contracts & Management*

*Unit 24: Project Management*

*Unit 36: Advanced Building Information Modelling*

## Unit 6: Construction Information (Drawing, Detailing, Specification)

<b>Unit code</b>	<b>D/615/1392</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

### Introduction

To achieve successful projects in the built environment requires a range of different types of information: to describe the project, quantify the materials, provide clear instructions for assembly and erection, and to allow for accurate costing and management. Throughout the process of design, construction and post-occupancy management, information is critical.

Through this unit students will develop their awareness of different types of construction information and their uses in the process. Students will engage in the production, reading and editing of construction information, in order to understand how this information informs different stages of the process. Using industry standard tools and systems, students will consider the ways that information may be shared and, through this, the value of collaboration in the information process.

Topics included in this unit are: construction drawing, detailing, Computer Aided Design (CAD), Building Information Modelling (BIM), schedules (door, window, hardware, etc.), specifications, schedules of work, bills of quantities and information distribution and collaboration.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Evaluate different types of construction information in the context of diverse project types
- 2 Develop construction drawings, details, schedules and specifications in support of a given construction project
- 3 Interpret different types of construction information in order to explain a construction project
- 4 Assess ways in which construction professionals collaborate in the production of construction information.

## Essential Content

### LO1 Evaluate different types of construction information in the context of diverse project types

*Construction drawings*

*Site plans*

*Floor plans, roof plans, ceiling plans*

*General arrangement*

*Elevations*

*Assembly drawings*

*Component drawings/details*

*Schedules*

*Door schedules*

*Window schedules*

*Hardware schedules*

*Specifications*

*Performance specification*

*Outline specification*

*Full specification*

*Specification templates/standards*

### LO2 Develop construction drawings, details, schedules and specifications in support of a given construction project

*Computer Aided Design (CAD)*

*Templates*

*Title blocks*

*Annotation*

*Building Information Modelling (BIM)*

*Specification software*

*Bills of quantities*

*Schedules of works*

**LO3 Interpret different types of construction information in order to explain a construction project**

*Reading construction drawings*

*Information co-ordination*

*Clash detection*

*'Red-lining'*

**LO4 Assess ways in which construction professionals collaborate in the production of construction information**

*Project roles*

*Information production*

*Hierarchy of roles and information*

*Project collaboration*

*Document sharing/distribution*

*Online/cloud-based collaboration*

Building Information Modelling (BIM).

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Evaluate different types of construction information in the context of diverse project types		<b>L01 and L02</b> <b>D1</b> Justify the use of specific types of construction information in support of a given project
<b>P1</b> Explain the use of construction information in the context of a project <b>P2</b> Describe the different types of construction information and their uses	<b>M1</b> Compare different types of construction information to identify their suitability in specific contexts.	
<b>L02</b> Develop construction drawings, details, schedules and specifications in support of a given construction project		
<b>P3</b> Develop a set of general arrangement drawings, selected details and door/window schedules <b>P4</b> Produce an outline bill of quantities	<b>M2</b> Compose a schedule of works	

Pass	Merit	Distinction
<p><b>LO3</b> Interpret different types of construction information in order to explain a construction project</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Propose corrections to construction drawings and specifications using industry standard forms of notation</p>
<p><b>P5</b> Relate a set of construction drawings to a specification</p> <p><b>P6</b> Evaluate construction drawings and details to identify 'clashes'</p>	<p><b>M3</b> Critique a body of construction information, identifying errors and discrepancies</p>	
<p><b>LO4</b> Assess ways in which construction professionals collaborate in the production of construction information.</p>		
<p><b>P7</b> Assess the types of information produced by different participants in a construction project</p> <p><b>P8</b> Examine the relationship between different bodies of information and how they work in conjunction</p>	<p><b>M4</b> Compare the roles of CAD and BIM in the collaborative production of construction information</p>	

## Recommended Resources

### Textbooks

CHING, F.D.K. (2014) *Building Construction Illustrated*. Chichester: John Wiley & Sons.

CHUDLEY, R. (2016) *Building Construction Handbook*. Abingdon, Oxon: Routledge.

Construction Specifications Institute (2011) *The CSI Construction Specifications Practice Guide*. Chichester: John Wiley & Sons.

HUTH, M.W. (2009) *Understanding Construction Drawings*. Delmar Cengage.

KALIN, M. and WEYGANT, R.S. (2010) *Construction Specification Writing: Principles and Procedures*. Chichester: John Wiley & Sons.

KUBBA, S. (2008) *Blueprint Reading: Construction Drawing for the Building Trade*. McGraw-Hill.

### Websites

[www.designingbuildings.co.uk](http://www.designingbuildings.co.uk)      Designing Buildings Wiki  
(General Reference)

[www.thenbs.com](http://www.thenbs.com)      The NBS  
Knowledge  
(General Reference)

[www.csinet.org](http://www.csinet.org)      CSI  
(General Reference)

### Links

This unit links to the following related units:

*Unit 1: Individual Project*

*Unit 14: Building Information Modelling*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 36: Advanced Building Information Modelling*



## Unit 7: Surveying, Measuring & Setting-out

<b>Unit code</b>	<b>H/615/1393</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

### Introduction

Infrastructure and new buildings are essential requirements of modern life. In both construction and civil engineering there is a need to conduct initial surveys to assist the design team in establishing a clearly defined starting point. Once designed, the priority becomes to 'set out' the structures to the required accuracy to facilitate the construction process. Finally, 'as built' surveys are necessary to assist future maintenance and improvements to the built asset.

This unit explores the techniques used to set up controls and conduct topographic surveys. It also covers communication of results and methods of Setting-out structures.

On successful completion of this unit students will be able to set up and assess the accuracy of control points. From these or any other control points the students will be able to complete a topographic survey or set out a structure. The students will also be able analyse errors in Setting-out and surveying.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Undertake a survey to establish a station network for horizontal and vertical control
- 2 Explain the process of undertaking a topographic survey
- 3 Apply industry standard techniques in the production, transferring and staking out of co-ordinates of multiple construction elements
- 4 Prepare a report on the causes of errors and techniques to improve accuracy, including the use of digital data.

## Essential Content

### LO1 Undertake a survey to establish a station network for horizontal and vertical control

*Description of types of control points*

*Primary controls, first and second order*

*Secondary control*

*Different methods of marking control points*

*The use of local, national and grid control available*

*Conducting a closed traverse*

*Carrying out a full closed traverse survey for horizontal and vertical controls*

*Methods for checking accuracy of the traverse*

*Matching the control station accuracy to national standards or recommendations*

*Calculations to obtain corrected co-ordinates*

### LO2 Explain the process of undertaking a topographic survey

*Purpose of a topographic survey*

*Links to initial control*

*Techniques to communicate a completed survey*

*Cut and fill information obtained from a survey*

*Methods of completing a topographic survey*

*Equipment to be used to capture topographic details*

*Use of free station and GPS to complete the survey*

*Coding systems for features to be surveyed*

*Data transfer techniques.*

**LO3 Apply industry standard techniques in the production, transferring and staking out of co-ordinates of multiple construction elements**

*Examples of construction elements*

Building outlines, centre lines of structural elements, boundary locations from national co-ordinates, road centre lines, drainage and hard landscape features.

*Setting-out techniques*

Holistic view of setting from the whole to the part

Use of free station, reference lines, stake out, tie distances within a total station program

Techniques to obtain Setting-out data, including data transfer

Process of Setting-out structures and offsetting lines of structural elements

Horizontal and vertical control of construction, both initially and as the work commences.

**LO4 Prepare a report on the causes of errors and techniques to improve accuracy, including the use of digital data**

*Errors in surveying and Setting-out*

Instrumentation error: prism constants, reflector heights, atmospheric influences, calibration certification, free station errors, discrete Setting-out

Human errors: alignment of levelling staffs and hand- or tripod-mounted prisms, physical Setting-out constraints

*Improvement of accuracy:*

Use of technology to provide checking methods

Testing procedures for instrumentation to be used in Setting-out and surveying

Comparing accuracy of set out element to nationally recognised standards.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Undertake a survey to establish a station network for horizontal and vertical control</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Assess the accuracy of a network in the production of a topographic survey</p>
<p><b>P1</b> Describe the types of control networks that are available for surveying, including examples of local and national stations</p> <p><b>P2</b> Carry out a closed traverse survey of a network, including at least five stations</p> <p><b>P3</b> Calculate corrected co-ordinates and heights for the stations and explain the stages used</p>	<p><b>M1</b> Calculate and compare the accuracy achieved in a closed traverse survey</p>	
<p><b>LO2</b> Explain the process of undertaking a topographic survey</p>		
<p><b>P4</b> Explain the process of conducting a topographic survey for a given plot of land, including initial control</p> <p><b>P5</b> Describe, with examples, common coding systems and data exchange processes, including communicating final outcomes</p>	<p><b>M2</b> Review the content of a topographic survey, including analysis of its suitability to assist the design team in completing the design</p>	

Pass	Merit	Distinction
<p><b>LO3</b> Apply industry standard techniques in the production, transferring and staking out of co-ordinates of multiple construction elements</p>		<p><b>D2</b> Analyse both the accuracy achieved and the techniques used during the practical exercise</p>
<p><b>P6</b> Extract and transfer the required data from a given project to a total station in order to allow Setting-out to commence</p> <p><b>P7</b> Complete a full Setting-out operation on a given project by utilising a total station free station programme, including both horizontal and vertical control</p>	<p><b>M3</b> Analyse the accuracy achieved from a Setting-out operation from tie distances recorded, total station stored data and another means</p>	
<p><b>LO4</b> Prepare a report on the causes of errors and techniques to improve accuracy, including the use of digital data.</p>		<p><b>D3</b> Analyse the techniques used to improve accuracy, including the implication of Setting-out errors and the application of industry standard technology/software</p>
<p><b>P8</b> Prepare a report on the common causes of errors in both Setting-out and surveying</p> <p><b>P9</b> Compare the accuracy of Setting-out data to national standards</p>	<p><b>M4</b> Evaluate the causes of errors in surveying, Setting-out and data transfer</p>	

## Recommended Resources

### Textbooks

IRVINE, W. and MACLENNAN, F. (2005) *Surveying for Construction*. 5th ed. London: McGraw-Hill.

SCHOFIELD, W. and BREACH, M. (2007) *Engineering Surveying*. 6th ed. Oxford: Elsevier.

SADGROVE, B.M. (2007) *Setting-out Procedures for the Modern Built Environment*. London: Ciria.

UREN, J. and PRICE, W. (2010) *Surveying for Engineers*. 5th ed. Basingstoke: Palgrave Macmillan.

### Websites

<a href="http://ice.org.uk">ice.org.uk</a>	Institution of Civil Engineers (General Reference)
<a href="http://tsa-uk.org.uk">tsa-uk.org.uk</a>	The Survey Association (General Reference)

### Links

This unit links to the following related units:

*Unit 11: Measurement & Estimating*

*Unit 13: Tender & Procurement*

*Unit 23: Contracts & Management*

*Unit 41: Surveying for Conservation, Renovation & Refurbishment*

*Unit 44: Advanced Surveying & Measurement*

## Unit 8: Mathematics for Construction

NOTE: This unit replaces K/615/1394 and is only suitable for students **registered FOR the 2019/20 (or later) academic year**.

For students **registered BEFORE the 2019/20 academic year**, please use K/615/1394 found in *Appendix 7: Legacy Units*.

<b>Unit code</b>	<b>J/617/6366</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The aim of this unit is to develop students' skills in the mathematical principles and theories that underpin the Construction, Civil Engineering and Building Services curriculum. Students will be introduced to mathematical methods and statistical techniques in order to analyse and solve problems within a construction engineering context.

Topics included in this unit are: trigonometry and algebraic mathematical techniques; matrices; statistical techniques; differential and integral calculus, binomial and normal distribution; dimensional analysis, arithmetic progressions; vector analysis.

On successful completion of this unit students will be able to employ mathematical methods within a variety of contextualised examples; use analytical and computational methods to evaluate and solve engineering construction problems; interpret data using statistical techniques and apply calculus techniques. Students will gain crucial employability skills such as critical thinking, problem solving, analysis, reasoning, and data interpretation.



## Learning Outcomes

By the end of this unit, a student will be able to:

- 1 Use analytical and computational methods to solve construction related problems
- 2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages
- 3 Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus.
- 4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis examples.

## Essential Content

### LO1 Use analytical and computational methods to solve construction related problems

#### *Analytical methods*

Trigonometry

irregular areas and volumes

sine rule

cosine rule

area of triangles applications

#### *Trigonometry*

coordinate systems

basic trigonometric ratios and their inverses

trigonometric ratios for the four quadrants

solution of triangles

areas and volumes of regular solids

#### *Algebra*

Linear

simultaneous and quadratic equations (graphical or algebraic solving)

#### *Matrices*

Multiplication

Transposition

inversion (up to 2 x 2)

#### *Application to construction problems*

analysis and design issues

processes and operations

resource issues e.g. labour, finance

project planning

levelling, contouring

triangulation, traversing, cut and fill, setting out.

## LO2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages

### *Statistical methods*

presentation of data (histograms, frequency graphs, cumulative frequency graphs)

### *Central tendency and dispersion*

dispersion (standard deviation, variance, interquartile range)

Distribution theory: normal distribution

confidence limits

Null hypothesis

significance testing.

### *Construction engineering problems*

measures of central tendency (mean, mode, median)

measures of dispersion (range, variance, standard deviation, quartiles, deciles and percentiles)

grouped and ungrouped data

Probability theory, Binomial and normal distribution

### *Applications*

presentation of data

estimation

prediction

quality control

**LO3 Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus**

*Differential calculus*

basic differentiation techniques applied to algebraic, trigonometric and logarithmic functions

products and quotients

function of a function

second order derivatives

the location of stationary values

*Integral calculus*

indefinite and definite integration techniques applied to algebraic, trigonometric and exponential functions

*Practical construction problems*

solution of problems involving maxima and minima

growth and decay

centroids

moments of inertia

areas under curves and volumes of revolution

use in electrical theory, structural mechanics, fluid mechanics as appropriate.

**LO4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems.**

*Trigonometrical techniques*

Vector analysis e.g. static forces, relative motion, frameworks

*Arithmetic progressions*

Dimensional analysis

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Use analytical and computational methods to solve construction related problems		<b>L01 and L02</b> <b>D1</b> Evaluate analytical and statistical findings from construction problems completed and justify the techniques adopted to solve such problems.
<b>P1</b> Solve construction problems using trigonometry techniques  <b>P2</b> Solve construction problems using algebraic techniques	<b>M1</b> Apply the use of matrices to solve problems	
<b>L02</b> Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages		
<b>P3</b> Apply statistical methods, including the calculation of the mean and standard deviation, to produce accurate and appropriate solutions to construction engineering problems  <b>P4</b> Calculate probabilities within both binomially distributed and normally distributed random variables	<b>M2</b> Interpret the results of a statistical hypothesis test conducted from a given scenario	

Pass	Merit	Distinction
<p><b>LO3</b> Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus</p>		<p><b>D2</b> Analyse differential calculus techniques in the determination of maxima and minima in construction industry-related problem.</p>
<p><b>P5</b> Use differential calculus techniques to solve functions which incorporate: <math>ax^n</math>, sine <math>ax</math>, cosine <math>ax</math>, <math>\log_e x</math>, <math>e^{ax}</math> and methods including function of a function</p> <p><b>P6</b> Use integral calculus techniques to determine indefinite and definite integrals of functions involving <math>ax^n</math>, sine <math>ax</math>, cosine <math>ax</math>, <math>1/x</math>, and <math>e^{ax}</math></p>	<p><b>M3</b> Apply the rules of integral calculus to determine solutions for complex construction related problems</p>	
<p><b>LO4</b> Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis examples.</p>		<p><b>D3</b> Evaluate the effectiveness and relevance, to the solving of complex construction problems, of the mathematical technique of vector analysis</p>
<p><b>P7</b> Apply dimensional analysis to solve problems</p> <p><b>P8</b> Generalise answers from a contextualised arithmetic progression problems</p>	<p><b>M4</b> Solve construction problems using vector analysis</p>	

## Recommended Resources

### Textbooks

SINGH, K. (2011) *Engineering Mathematics Through Applications*. 2nd ed. Basingstoke: Palgrave Macmillan.

STROUD, K.A. and BOOTH, D.J. (2013) *Engineering Mathematics*. 7th ed. Basingstoke: Palgrave Macmillan.

### Websites

mathcentre.ac.uk	Mathcentre (Tutorials)
mathtutor.ac.uk	Mathtutor (Tutorials)

### Links

This unit links to the following related units:

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 17: Principles of Public Health Engineering*

*Unit 18: Civil Engineering Technology*

*Unit 19: Principles of Electrical Design & Installation*

*Unit 28: Further Mathematics for Construction*

*Unit 30: Advanced Structural Design*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 33: Advanced Electrical Design & Installation*

*Unit 43: Hydraulics*

## Unit 9: Principles of Heating Services Design & Installation

<b>Unit code</b>	<b>M/615/1395</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The buildings we use in everyday life – to work, study, socialise and live in – are increasingly complex in their design as well as being subject to more stringent environmental targets for emissions. Within these buildings, heating systems play a major part in maintaining the comfort of the occupants.

This unit will introduce students to the principles of the design and installation of heating systems for non-domestic buildings.

Subjects included in this unit are: the design process, pre-design/design brief, the production of design data, thermal comfort, calculation of U-values, heat loss calculation, total heating loads and heating plant capacity, heating media and distribution systems, system layouts, heat emitters, heat sources, heating system components, sizing and specification of heating system components, and commissioning, testing and handover procedures.

On successful completion of this unit students will understand the principles of the design, sizing and specification of non-domestic heating systems and components.



## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Identify pre-design information required for a non-domestic heating system
- 2 Analyse heating loads for non-domestic buildings
- 3 Design a non-domestic heating system for a given building type
- 4 Justify the selection of non-domestic heating system components and installation strategy.

## Essential Content

### LO1 Identify pre-design information required for a non-domestic heating system

#### *The design process:*

Design stages and tasks

Legislation

Health & safety

Design constraints

Sustainability.

#### *Pre-design/design brief:*

Building form

Building orientation

Air tightness

Fabric insulation

Glazing

Thermal mass

Occupancy, usage details

Potential internal loads

Cost plan.

#### *Design data*

*Thermal comfort*

### LO2 Analyse heating loads for non-domestic buildings

#### *U-values:*

Calculation of U-values for composite structures.

#### *Heat loss calculation:*

Calculation of heat losses, ventilation heat losses.

*Total heating loads and heating plant capacity:*

Plant diversity

Plant configuration

Single and multiple boiler options

Minimising heat loads.

### **LO3 Design a non-domestic heating system for a given building type**

*Heating media and distribution systems:*

Requirements of the heating system

Radiant and convective output

Distribution

Zoning options

Integration with domestic hot water (DHW) requirements, integration with low-carbon technology options.

*Heating media options:*

Radiant, air, water

Low pressure hot water (lphw)

Medium pressure hot water (mphw)

High pressure hot water (hphw) and steam.

*System layouts:*

Centralised or de-centralised

Distribution system layout options

Two-pipe

Reverse return

Constant flow and variable flow systems.

*Heat emitters:*

Radiators

Natural convectors

Underfloor heating

Fan convectors

Radiant panels.

*Heat sources:*

Direct and indirect options

Conventional boilers or other heat sources such as heat pumps or combined heat and power (CHP)

Fuel options and possible storage requirements

Boiler and burner types

Plant room design requirements

Flue and chimney design.

*Heating system components:*

Pipework

Pumps

Pressurisation units

Expansion vessels

Low loss headers

Air and dirt separators

Pipework expansion devices

Regulating valves

Fire collars.

**LO4 Justify the selection of non-domestic heating system components and installation strategy**

*Sizing and specification of heating system components:*

Pipes

Pumps

Pressurisation units

Expansion vessels

Low loss header

Air and dirt separators

Pipework expansion devices

Regulating valves

Fire collars.

Commissioning, testing and handover procedures

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Identify pre-design information required for a non-domestic heating system		<b>LO1 and LO2</b>  <b>D1</b> Analyse the Health & Safety and environmental legislation relevant to the design, installation and operation of a non-domestic heating system
<b>P1</b> Explain the design process stages and tasks that must be considered for the design of a non-domestic heating system  <b>P2</b> Discuss the information that should be included in a design brief for a non-domestic heating system design  <b>P3</b> Produce design data for a heating system in a given building	<b>M1</b> Evaluate the design considerations and possible constraints for a given building type provided, with reference to legislation and possible Health & Safety considerations  <b>M2</b> Analyse human comfort requirements	
<b>LO2</b> Analyse heating loads for non-domestic buildings		
<b>P4</b> Calculate U-values for a given structure  <b>P5</b> Calculate heat loss for spaces within a given building  <b>P6</b> Calculate the total heating load for a given building	<b>M3</b> Analyse the current requirements for minimum U-values in domestic and non-domestic buildings, including infiltration rates	

Pass	Merit	Distinction
<b>LO3</b> Design a non-domestic heating system for a given building type		<b>LO3 and LO4</b> <b>D2</b> Analyse a range of sustainable options suitable for the heating system in a given building
<b>P7</b> Discuss suitable alternative heating strategies for a given building  <b>P8</b> Explore the design criteria for the selection of heat emitters and heat source, and the criteria for their selection  <b>P9</b> Produce a design proposal for a non-domestic heating system	<b>M4</b> Select a suitable heating strategy for a given building and analyse the reasons behind their selection  <b>M5</b> Justify the selection of suitable heat emitters and heat source for a given building and analyse their selection	
<b>LO4</b> Justify the selection of non-domestic heating system components and installation strategy.		
<b>P10</b> Calculate sizes of pipework for a given building  <b>P11</b> Identify the index circuit and calculate the pipework resistance  <b>P12</b> Justify the selection of a range of non-domestic heating system components	<b>M6</b> Discuss how the selection of different components impacts on an installation strategy	

## Recommended Resources

### Textbooks

CHADDERTON, D. (2013) *Building Services Engineering*. 6th ed. Abingdon: Routledge.

CIBSE (2015) *CIBSE Guide A: Environmental design*. 8th ed. London: CIBSE.

CIBSE (2005) *CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration*. London: CIBSE.

RACE, G.L. (2006) *CIBSE Knowledge Series: KS8: How to Design a Heating System*. London: CIBSE.

TEEKARAM, A. (2006) *CIBSE AM14: Non-domestic Hot Water Heating Systems*. London: CIBSE.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 8: Mathematics for Construction*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 17: Principles of Public Health Engineering*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 43: Hydraulics*

# Unit 10: Principles of Ventilation & Air Conditioning Design & Installation

<b>Unit code</b>	<b>D/615/1926</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The demands of modern living as well as the potential impact on the environment has meant that the building services engineer has become a key member of the building design team. The spaces that we occupy must be provided with ventilation to allow us to function and, where required, the addition of cooling helps to avoid the building overheating and maintains a comfortable environment for the occupants.

This unit will introduce students to the principles of the design and installation of these ventilation and air conditioning systems that are present in all of the buildings we use in everyday life.

Subjects included in this unit are: the production of pre-design/design briefs, design data, cooling loads, total cooling loads, cooling plant capacity, building overheating, peak summertime temperatures, sizing and specification of ventilation and air conditioning system components, and the commissioning, testing and handover procedures.

On successful completion of this unit students will understand the principles of ventilation and air conditioning systems.



## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Identify pre-design information required for a non-domestic ventilation and air conditioning system
- 2 Analyse cooling load for non-domestic buildings
- 3 Present a design for a non-domestic ventilation and air conditioning system for a given building type
- 4 Justify the selection of non-domestic ventilation and air conditioning components and an installation strategy.

## Essential Content

### LO1 Identify pre-design information required for a non-domestic ventilation and air conditioning system

#### *The design process:*

Design stages and tasks

Legislation

Health & safety considerations

Possible design constraints

Sustainability.

#### *Pre-design/design brief:*

Building form and orientation to optimise the impact of solar gain

Building air tightness to reduce infiltration

Fabric insulation

Optimisation of glazing

Balancing daylighting needs against thermal performance

Building thermal mass

Required functional performance

Occupancy

Usage details

Potential internal gains

Internal design conditions

Cost plan.

#### *Design data:*

External design data

Internal design condition

Selection of ventilation rates

Publications and guides

Statutory requirements.

## LO2 **Analyse cooling load for non-domestic buildings**

### *Cooling loads due to solar radiation:*

Solar geometry and terminology

Direct and diffuse solar radiation

Calculation of solar irradiance on vertical, horizontal and pitched surfaces

Transmission of solar radiation on building structures.

### *Total cooling load and cooling plant capacity:*

Factors contributing to cooling plant capacity

Assessment of total heat gains to the interior

Effect of building construction and orientation

Use of tables

Reference data and software to determine cooling loads for rooms, zones and buildings.

### *Strategies to prevent building overheating:*

Effect of shadows and shading

Passive and active cooling measures.

### *Peak summertime temperatures:*

Calculation and assessment of peak summertime temperatures in rooms

Use of tables

Reference data and computer software.

### LO3 **Present a design for a non-domestic ventilation and air conditioning system for a given building type**

#### *Possible strategies:*

Natural ventilation

Types of mechanical ventilation systems

Mechanical comfort cooling and close control air conditioning systems

Interrelationship of ventilation and air conditioning with other mechanical and electrical building services.

#### *Ventilation systems:*

Natural ventilation systems

Mechanical ventilation systems

Mixed mode and displacement ventilation systems

Process, fume and dust extraction systems

Free cooling and night purging

Mechanical ventilation heat recovery (MVHR) systems.

#### *Air conditioning systems:*

Properties and characteristics of comfort cooling and close control application

Humidity control

Cooling coils: direct expansion (DX) and chilled water

Centralised and local plant selection

Air conditioning systems, including: constant volume (CV), variable air volume (VAV), fan coils units, chilled beams, chilled ceilings, room-based heat pumps (versatemp systems), split systems, heat pumps, variable refrigerant flow (VRF) systems.

#### LO4 **Justify the selection of non-domestic ventilation and air conditioning components and an installation strategy**

*Sizing and specification of ventilation system components:*

Duct sizing

Fan sizing

Fan selection and fan laws

Damper sizing and selection

Air handling unit (AHU) sizing and selection

Grille and diffuser sizing and selection.

*Sizing and specification of air conditioning system components:*

Psychrometric principles

Use of psychrometric charts to size cooling and heating coils and humidification requirements

Refrigeration principles

Plotting refrigeration cycles and calculation of coefficient of performance (COP)

Sizing and specification of heat pumps and VRF systems.

*Commissioning, testing and handover procedures:*

Current standards and procedures for commissioning ventilation and air conditioning systems

Commissioning procedures for ventilation and air conditioning system components

Commissioning schedules and handover documentation.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Identify pre-design information required for a non-domestic ventilation and air conditioning system		<b>LO1 and LO2</b>  <b>D1</b> Analyse Health & Safety and environmental legislation relevant to the design, installation and operation of a non-domestic ventilation and air conditioning system
<b>P1</b> Explain the design process stages and tasks for the design of a non-domestic ventilation and air conditioning system  <b>P2</b> Discuss the information included in a design brief for a non-domestic ventilation and air conditioning system design  <b>P3</b> Produce design data for a ventilation and air conditioning system in a given building	<b>M1</b> Evaluate the design considerations and constraints for the design of a non-domestic ventilation and air conditioning system for a given building	
<b>LO2</b> Analyse cooling load for non-domestic buildings		
<b>P4</b> Calculate the heat gains for a room within a given building  <b>P5</b> Calculate the total cooling load for a given building  <b>P6</b> Calculate the peak summertime temperature for rooms in a given building	<b>M2</b> Analyse strategies that could be used to reduce the total cooling load calculated for the given building  <b>M3</b> Analyse the peak summertime temperatures calculated, making suitable recommendations	

Pass	Merit	Distinction
<p><b>LO3</b> Present a design for a non-domestic ventilation and air conditioning system for a given building type</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Evaluate sustainable options for inclusion in a ventilation and air conditioning strategy for a given building type</p>
<p><b>P7</b> Discuss ventilation strategies for a given building</p> <p><b>P8</b> Present a ventilation and air conditioning design proposal for a given building type</p>	<p><b>M4</b> Compare different ventilation strategies to determine best practice</p>	
<p><b>LO4</b> Justify the selection of non-domestic ventilation and air conditioning components and an installation strategy.</p>		
<p><b>P9</b> Specify ventilation and air conditioning components, including ductwork sizing for a given building</p> <p><b>P10</b> Justify the selection of components for a non-domestic ventilation and air conditioning system</p>	<p><b>M5</b> Discuss the effect of different duct sizing on the performance of a ventilation and air conditioning installation</p>	

## Recommended Resources

### Textbooks

CHADDERTON, D. (2013) *Building Services Engineering*. 6th ed. Abingdon: Routledge.

CHADDERTON, D. (2014) *Air Conditioning: A Practical Guide*. 3rd ed. Abingdon: Routledge.

CIBSE (2015) *CIBSE Guide A: Environmental design*. 8th ed. London: CIBSE.

CIBSE (2005) *CIBSE Guide B: Heating, Ventilating, Air Conditioning and Refrigeration*. London: CIBSE.

JONES, W. (2001) *Air Conditioning Engineering*. 5th ed. Oxford: Elsevier.

RACE, G.L. (2012) *CIBSE Knowledge Series: KS20, Practical Psychrometry*. London: CIBSE.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 17: Principles of Public Health Engineering*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 43: Hydraulics*



# Unit 11: Measurement & Estimating

<b>Unit code</b>	<b>A/615/1397</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The techniques explored within this unit are essential skills in maintaining the competitive position of a construction firm; in obtaining work through the procurement routes of construction. Mastering the skills of measurement and estimating are essential for the quantity surveyor and estimator.

The overall aim of this unit is to provide students with an understanding of the quantity surveying techniques of measurement and the estimation of rates for the compilation of tender information. This is a vital activity in achieving a successful outcome for a contracting company in tendering and winning work.

Topics included within this unit are: estimating techniques, standard methods of measurement, taking-off dimensions, preparation of bills of quantities, estimating data collection and the assembly of an estimate for a work package.

On successful completion of this unit students will be in a position to take-off quantities from drawn information and to prepare estimates for work packages. In addition, students will have the fundamental knowledge and skills to progress on to a higher level of study.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Define standard measurement techniques used for taking-off quantities for estimating purposes
- 2 Perform taking-off techniques in the production of a range of quantities for a structure
- 3 Interpret the principles and techniques of estimating in compiling a final price
- 4 Prepare an estimate for a work activity.

## Essential Content

### LO1 Define standard measurement techniques used for taking-off quantities for estimating purposes

#### *Techniques for quantifying budgets:*

Preliminary, intermediate and final estimates for clients budgets, Project Comparison Estimating using historical project cost data, use of Building Cost Information Service (BCIS), square meter and cubic meter estimates, elemental estimating, approximate quantities techniques, measurement using dimension paper, measurement using software packages.

#### *Standard methods of measurement for taking-off quantities:*

For construction, civil engineering and building services engineering, format, coding schemes, measurement rules, dimension sheets

Standard Method of Measurement 7, New Rules of Measurement, NRM 1 Order of cost estimating and elemental cost planning, MRM 2 Detailed measurement for building works, NRM 3 Order of cost estimating and cost planning for building maintenance works, Civil Engineering Standard Method of Measurement 4 (CESMM4), FIDIC contracts for use in international organisations.

#### *Uses:*

Project stages, client's budget, preliminary stages, project comparison stages, final design stage, preparation of bills of quantities for the tendering for work, sub-contract and supply chain packages, final account, maintenance and refurbishment works.

### LO2 Perform taking-off techniques in the production of a range of quantities for a structure

#### *Measurement techniques and processes:*

Techniques e.g. traditional (using dimension paper), abstraction of quantities, associated working up processes and preparation of bill of quantities pages, computer aided systems, use of digitisers.

*Taking-off:*

Substructure elements, foundations: mass fill, pad and raft, excavation works, filling, ground floors, drainage, manholes, service installations, road kerbs, channels and foundations, road surfacing, external works

Superstructure elements, walls, intermediate floors, roof structures and coverings, in situ concrete works, masonry, steel framed commercial structures, pre-cast concrete frames, building services, mechanical and electrical installations.

*Application:*

To construction projects (simple work sections, trade sections), use of annual techniques, use of software for taking-off dimensions, use of digitisers to take dimensions from drawings, integration packages using CAD, and estimating.

**LO3 Interpret the principles and techniques of estimating in compiling a final price**

*Collection of data:*

Characteristics, labour, labour costs, plant rates data, company data on output levels, cost of materials, terms of supply, delivery costs, handling, wastage, conversion.

*Processes and procedures for estimate:*

Factors affecting prime costs, method statements (effect on estimating), use of standard reference documents, coverage rules for units of work, e.g. Standard Method of Measurement (SMM) 7, New Rules of Measurement (NRM), Civil Engineering Standard Method of Measurement (CESMM), and any other measurement rules used in the specific form of locale measurement rules.

*Calculation of unit rates in building up an estimate:*

Labour, plant and materials, overheads and margin, outputs: recorded historically, price books, assimilated, LOSC Labour only sub-contractor (LOSC) rates, governed by plant outputs and capacities

Plant: purchase or hire options

Materials: wastage, purchase price, delivery costs.

*Adjustments to unit rates in building up an estimate:*

Historical rates adjusted for time, inflation, risk, technology, alternative plant, location, price increases.

#### LO4 **Prepare an estimate for a work activity**

##### *Estimating techniques for budgeting purposes:*

Preparation of approximate quantities for cost budgets, elemental cost estimating from given historical cost data, use of preliminary design drawings, preparation of estimate using BCIS comparative cost data, any other forms of local cost data, adjustments for time, size and quality, inflation and overheads.

##### *Estimating techniques:*

Application of all in rates to quantities, total net value, overheads and profit, preliminary items, VAT, pricing in risk, factors affecting risk, inclusion of sub-contracted elements, effect of location, contract period, inclusion of provisional items, use of standard templates and forms, use of ISO 9000 company devised systems.

##### *Application:*

Estimation of a work package or activity costs from given data in compiling a final estimate for submission to a client as part of a tendering process.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Define standard measurement techniques used for taking-off quantities for estimating purposes		<b>D1</b> Critically evaluate an estimating technique to its accuracy in the production of quantities
<b>P1</b> Explain the techniques used in the production of accurate quantities  <b>P2</b> Explain how a rule of measurement supports accurate quantities	<b>M1</b> Compare techniques used for production of quantities against the lifecycle of a project	
<b>LO2</b> Perform taking-off techniques in the production of a range of quantities for a structure		<b>D2</b> Produce an accurate bill of quantities work section from final design drawings
<b>P3</b> Take-off quantities using dimension paper for a range of construction activities  <b>P4</b> Abstract a range of quantities for construction activities	<b>M2</b> Accurately apply a standard method of measurement to the production of quantities	
<b>LO3</b> Interpret the principles and techniques of estimating in compiling a final price		<b>LO3 and LO4</b>  <b>D3</b> Evaluate estimating techniques used for the different stages of a project's lifecycle
<b>P5</b> Calculate labour unit rates for an estimate by compiling and processing rate build-up data  <b>P6</b> Calculate all in rates for a range of construction activities	<b>M3</b> Analyse the factors that have an effect upon the compilation of unit rates for an estimate	
<b>LO4</b> Prepare an estimate for a work activity		
<b>P7</b> Produce a comprehensive estimate for a work section or activity  <b>P8</b> Explain the reasons for the level of variation in estimates received by stakeholders	<b>M4</b> Compare the techniques used for the formulation of budgets with estimating final design costs	

## Recommended Resources

### Textbooks

BROOK, M. (2008) *Estimating and Tendering for Construction Work*. 4th ed. London: Spon Press.

CARTLIDGE, D. (2013) *Estimators Pocket Book*. London: Routledge.

GREENHALGH, B. (2013) *Introduction to Estimating*. London: Routledge.

OSTROWSKI, S. (2013) *Guide to Measurement Using the New Rules of Measurement*. Chichester, West Sussex: Blackwell.

RICS (2012) *New Rules of Measurement NRM 1: Order of Cost Estimating and Cost Planning for Capital Building Works*. 2nd ed. Norwich: Page Bros.

SCHMID, K. (2011) *Construction Estimating*. New York: Momentum Press.

### Links

This unit links to the following related units:

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 8: Mathematics for Construction*

*Unit 13: Tender & Procurement*

*Unit 23: Contracts & Management*

*Unit 34: Advanced Quantities for Complex Building Projects*

*Unit 44: Advanced Surveying & Measurement*

# Unit 12: Financial Management & Business Practices in Construction

<b>Unit code</b>	<b>F/615/1398</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The contemporary construction company operates within a very competitive sector of the economy. Company sizes range from small, sole trader, organisations to large, multi-national, companies. Construction companies have evolved business practices to ensure economic survival and growth. However, they continue to be impacted by the construction market, as well as external factors; such as, interest rates and government legislation.

This unit introduces the concepts of business management and financial control. Students will examine a range of factors that influence the ways in which companies grow, raise finance and control their costs and resources.

Topics included in this unit are: the legal status of building companies and how this impacts on raising finance, the different sources of finance and how a company manages them, contemporary management strategies, and how the day-to-day management of the different resources used by a construction company impact on their success.

On successful completion of this unit students will be able to analyse the legal status of different types of construction companies, the business strategies of construction companies and how they raise and manage their finances and the management of the resources at the construction company's disposal.



## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Explain the legal status of different types of building companies
- 2 Explore different sources of finance available to a construction company and strategies used to manage finance
- 3 Evaluate forms of company organisation within the contemporary construction industry
- 4 Illustrate the different strategies used by a construction company to manage resources.

## Essential Content

### LO1 Explain the legal status of different types of building companies

#### *Company status:*

Sole trader, partnership, limited and unlimited companies, incorporated companies.

#### *Legal statutes surrounding companies:*

Company law, responsibility to shareholders, bankruptcy and insolvency.

#### *Key legal characteristics of registered companies:*

Registering a company: Memorandum of Association, Articles of Association, statement of capital and initial shareholdings, choosing a company name.

#### *Types of finance:*

Equity, debt and lease financing, debentures, shares (ordinary, preference and 'called-up'), share values.

#### *Winding-up and dissolution:*

Voluntary, compulsory, insolvency, secured and unsecured creditors, distribution of assets

Winding-up: member's and creditor's winding-up.

### LO2 Explore different sources of finance available to a construction company and strategies used to manage finance

#### *Types of capital:*

Short-term, long- to medium-term, loans: retail/clearing bank loan, investment/merchant bank, mezzanine finance.

#### *Managing finance:*

Simple interest and compound interest, future planning and present value, sinking fund, discounted cash flow techniques, net present value, capital gearing, leverage.

#### *Company accounts:*

Double-entry bookkeeping, trading position, balance sheet analysis, ratio analysis, financial reporting for public companies, cash flow analysis.

**LO3 Evaluate forms of company organisation within the contemporary construction industry**

*Company organisation*

Corporate governance, strategic and operational strategies, corporate ethics (corporate social responsibility, sustainability, labour practices).

*Organisation structures:*

Span of control, communication, matrix organisations, head office and site management structures, education and training, health, safety and welfare provisions, Construction Skills Certification Scheme.

*Management philosophies:*

Personnel development, motivation and incentivisation, leadership styles, direct, sub-contract and agency labour, collaboration and communication.

**LO4 Illustrate the different strategies used by a construction company to manage resources**

*Labour:*

Skilled or semi-skilled, sub-contract or direct labour, incentive schemes, personnel reviews.

*Materials:*

Ordering, delivery strategies, storage, movement.

*Plant:*

Hire or buy, selection process, setting hire rate.

## Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
<b>LO1</b> Explain the legal status of different types of building companies			
<b>P1</b> Differentiate between the different statuses of construction companies	<b>M1</b> Compare different company types and advise on a suitable type for a given context	<b>D1</b> Assess the different strategies available for winding-up or dissolution of a construction company	
<b>P2</b> Explain the legal requirements relating to different companies in relation to their status			
<b>LO2</b> Explore different sources of finance available to a construction company and strategies used to manage finance			
<b>P3</b> Explore the different sources of capital, available for borrowing, by the construction company	<b>M2</b> Analyse the borrowing requirements for a given project	<b>D2</b> Analyse the balance sheet of a typical construction company	
<b>P4</b> Discuss a range of techniques for assessing the cost of borrowing			
<b>LO3</b> Evaluate forms of company organisation within the contemporary construction industry			
<b>P5</b> Discuss the strategic policies of a construction company	<b>M3</b> Differentiate between strategic and operational management strategies	<b>D3</b> Appraise a range of different management leadership styles for suitability for construction management	
<b>P6</b> Evaluate the different organisation structures of a range of different sizes of construction company	<b>M4</b> Assess company organisational structures in relation to collaborative working practices		
<b>P7</b> Discuss the education and training needs of a range of different construction personnel			

Pass	Merit	Distinction
<b>LO4</b> Illustrate the different strategies used by a construction company to manage resources		<b>D4</b> Evaluate different strategies to be used for incentivising labour productivity on-site
<b>P8</b> Describe the labour management strategies used by the construction company  <b>P9</b> Describe the management strategies for dealing with materials on-site	<b>M5</b> Discuss the factors to be considered when comparing the purchase or hire of plant and equipment	

## Recommended Resources

### Textbooks

GRIFFITH, A. (2011) *Integrated Management Systems for Construction*. 1st ed. Harlow: Pearson.

KIRKHAM, R. (2007) *Cost Planning of Buildings*. 8th ed. Oxford: Blackwell.

NICHOLSON, M. (2006) *Mastering Accounting Skills*. 3rd ed. Basingstoke: Macmillan.

### Links

This unit links to the following related units:

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 13: Tender & Procurement*

*Unit 23: Contracts & Management*

*Unit 24: Project Management*

*Unit 25: Management for Complex Building Projects*

*Unit 45: Maintenance & Operations*

# Unit 13: Tender & Procurement

<b>Unit code</b>	<b>J/615/1399</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

For a client, the process of procurement, obtaining the services of a main contractor to construct their project, is often complex. The selection of a contractor that will meet the expectations of a client is essential, so that time, quality and cost constraints are met, with no delays, overruns or budgets exceeded. Tendering is the process of obtaining a price for the designed and specified works. The importance associated with contractor selection cannot be overstated for the successful completion of a client's project.

The aim of this unit is to provide students with the knowledge to select a procurement route and an appropriate tendering method in the awarding of a project to a main contractor. Students will gain knowledge of how to prepare a tender package in procuring a contractor for a client's work. Many different procurement methods are available to achieve this: from open to closed systems.

Topics included within this unit are: tendering constraints and information, the documentation needed to send out a tender, the factors that affect procurement, and the procurement methods that can be used to select a contractor.

On successful completion of this unit students will be able to obtain an estimate for a client's project, at the design stage, using a suitable procurement method. In addition, students will have the fundamental knowledge and skills to progress on to a higher level of study.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Define what constitutes a tender and the information required for this process
- 2 Explain the procedures and contractual arrangements for tendering
- 3 Analyse the factors that affect the selection of construction procurement methods
- 4 Calculate an estimate for a work activity.



## Essential Content

### LO1 Define what constitutes a tender and the information required for this process

#### *Information required to produce a tender:*

Decision to tender, preliminary information received, type of client or stake holder, private or commercial clients, stage of the design drawings, provisional timescale, pre-contract Health & Safety plans, elements required for tender, tender resource allocations, electronic or hardcopy tender process, type of work, capacity to tender.

#### *Constraints on tendering:*

Time allocated to the compilation of tender documentation, selection of list of tenderers, allocated tendering time, return date and time, resources implications in terms of hardcopy, poor tender presentation, insufficient information sent out to contractors, revisions to design.

#### *Tendering documentation:*

Design drawings, tender drawings, covering invitation letter, the form of tender, tender submission breakdown, list of drawings, specification, bill of quantities, preliminaries, pre-construction information, form of contract to be used on the project, contract conditions and terms, tender pricing document, employers requirements, nominated and named contractors, a building information model, tender return instructions, tender return envelope, references to any code of practice for tendering procedures, Building Information Modelling.

### LO2 Explain the procedures and contractual arrangements for tendering

#### *Tendering stages:*

Decision to tender, tender preparation strategy, tendering arrangements, pre-qualification questionnaire, compiling lists of prospective tenderers

Selection criteria: experience, references, professional association status, ISO registration, recommendations, clients, preferences, interview, presentation, financial accounts, Health & Safety record, rotation on a select list, listing against financial capacity, previous performance feedback.

*Tendering processes:*

Types of tendering: open, selective, negotiated, serial, framework tendering, single stage and two stage tendering, advantages and disadvantages of each approach applied to a project, criteria for the selection of tendering method, reference to type of contract, design and build, size of project, financial costs.

*Contractual arrangements:*

Criteria for the selection of type of contract e.g. forms and agreements, terms and conditions, schedule of rates, lump sum, design and build, legal responsibilities

Standard forms of contract: Joint Contracts Tribunal (JCT), New Engineering Contract (NEC), and any local contractual agreement or documents e.g. FIDIC, International Construction Contracts, level of information provided at tendering stage.

**LO3 Analyse the factors that affect the selection of construction procurement methods**

*Issues associated with procurement of projects:*

Current issues (associated with procurement and contractual arrangements), issues originating from government, professional and statutory bodies and contracting organisations, recommendations from the sector and government-sponsored reports, differences between public and private procurement, developments and trends in practice e.g. Building Information Modelling L2 for public sector and asset procurement, aspects of practice, Official Journal of the European Union (OJEC), procurement strategy within Europe under the European Procurement Directives, International Trade Agreements and Government Directives.

*Factors affecting procurement routes:*

Time, cost, quality, client characteristics e.g. government or private sector, the project characteristics, time frame factors, level of risk associated with the project and what apportionment between client and contractor, environmental considerations, sustainability, financial planning, stage of the design (fully designed, partially), complexity of the building in terms of different services procured separately and nominated, OJEC rules and compliance with European bidders.

#### LO4 Calculate an estimate for a work activity

##### *Project parameters:*

Client's budget, client's agreed procurement strategy, project balance, risk and project management, available procurement time against design detail completed, fast track construction and the stages when design information will be available, level of specified quality required, policy constraints (internal and external), cost constraints in terms of value and contractors approved lists, auditable value for money, political constraints, level of client knowledge.

##### *Procurement methods and contractual arrangements:*

Common methods of procurement: traditional contract, single and two stage design and build, management contract or contract management, lump sum with bill of quantities, lump sum with specification, prime contracting, associated contract with method of procurement, Building Information Modelling.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Define what constitutes a tender and the information required for this process		<b>D1</b> Critically evaluate the use of specifications or bills of quantities in terms of providing a competitive tender
<b>P1</b> Explain the information required to be produced prior to tendering <b>P2</b> Explain the documentation required to formulate a tender for a major project <b>P3</b> Discuss the potential benefits of Building Information Modelling in the tender and procurement process	<b>M1</b> Compare the use of specifications and bills of quantities as tendering methods used for a privately funded project	
<b>LO2</b> Explain the procedures and contractual arrangements for tendering		
<b>P4</b> Present the results of a taking-off procedure in producing a bill of quantities <b>P5</b> Describe the relationship between the type of tender and different taking-off techniques for a procurement strategy	<b>M2</b> Compare the types of tendering available for a design and build project	<b>D2</b> Evaluate the relationship between taking-off techniques and the type of contractual arrangements for a project

Pass	Merit	Distinction
<b>L03</b> Analyse the factors that affect the selection of construction procurement methods		<b>L03 and L04</b> <b>D3</b> Assess the effect of a given estimating technique on the selection of a procurement method for a major project
<b>P6</b> Explore the factors that affect private and public procurement routes for a client <b>P7</b> Explain the factors that determine the selection of an estimating technique	<b>M3</b> Analyse the procurement processes for a public stakeholder	
<b>L04</b> Calculate an estimate for a work activity		
<b>P8</b> Describe the common methods of estimating for individual work activities <b>P9</b> Produce an estimate for a given work activity in relation to a major project	<b>M4</b> Compare the results of different estimation techniques on the cost for a given work activity in a major project	

## Recommended Resources

### Textbooks

BROOK, M. (2008) *Estimating and Tendering for Construction Work*. 4th ed. London: Spon Press.

FINCH, R. (2011) *NBS Guide to Tendering Construction Projects*. London: RIBA Publishing.

HUGHES, W., HILLEBRANDT, P., GREENWOOD, D. and KWAWU, W. (2006) *Procurement in the Construction Industry*. Abingdon, Oxon: Taylor & Francis.

MORLEDGE, R. and SMITH, A. (2013) *Building Procurement*. 2nd ed. Chichester, West Sussex: Wiley-Blackwell.

TREBES, B. and MITCHELL, B. (2012) *NEC Managing Reality Book One Introduction to the Engineering and Construction Contract*. 2nd ed. London: ICE Publishing.

### Links

This unit links to the following related units:

*Unit 4: Construction Practice & Management*

*Unit 8: Mathematics for Construction*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 23: Contracts & Management*

*Unit 34: Advanced Quantities for Complex Building Projects*

*Unit 41: Surveying for Conservation, Renovation & Refurbishment*

*Unit 44: Advanced Surveying & Measurement*

# Unit 14: Building Information Modelling

<b>Unit code</b>	<b>M/615/1400</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The aim of this unit is to provide students with the background knowledge and understanding of Building Information Modelling (BIM) in the context of the construction industry. Students will be introduced to the drivers and benefits associated with BIM, as well as the terminology which surrounds BIM.

Topics included in this unit are: the relationship between design, construction and operation, and the relevance of information management in regard to BIM and how these concepts influence the entire process of the way an asset is managed and maintained.

The knowledge and skills gained in this unit will allow students to understand the importance of Building Information Modelling in the context of current roles and responsibilities that exist within the construction industry, and effectively understand how this may influence future choices in their professional career.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Discuss the term Building Information Modelling in the context of local, national and global developments in the construction industry
- 2 Describe the basic concepts surrounding Building Information Modelling
- 3 Discuss the differences in purpose between Building Information Modelling and its associated outcomes, and traditional forms of construction information
- 4 Assess ways in which the design and construction process of an asset influences the way that asset is managed and maintained.



## Essential Content

### LO1 **Discuss the term Building Information Modelling (BIM) in the context of local, national and global developments in the construction industry**

*Definition of the term Building Information Modelling*

*Key terms and definitions that relate to BIM*

*The differences between traditional methods and a BIM-enabled process*

*The importance of BIM in the context of the construction industry*

*The importance of BIM in a global context and the need to export skills*

*Construction processes that support BIM and how they can save on time and cost*

*BIM across an asset lifecycle*

*Managing construction information during across the life of a BIM-enabled project*

*BIM terminology and abbreviations*

### LO2 **Describe the basic concepts surrounding Building Information Modelling**

*The basic principles of BIM*

*BIM dimensions: 3D, 4D, 5D, 6D*

*BIM maturity levels and guidance toward determining how to achieve BIM Level 2*

*Standards supporting BIM and an overview of other supporting documentation*

*Technology that supports BIM*

*The importance of collaborative working in regard to BIM*

*Information management and BIM*

*Information delivery and Processes that effectively support BIM*

*The exchange of information across a project lifecycle*

*The creation of BIM data: how, why and what*

*Sharing BIM data effectively*

*Managing data across differing stages of a project*

**LO3 Discuss the differences in purpose between Building Information Modelling and its associated outcomes, and traditional forms of construction information**

*The differences between traditional methods and a BIM-enabled process*

*The main benefits of BIM*

*Challenges of BIM*

*Drivers that support BIM*

*Enablers of BIM*

*Waste and inefficiency*

*Government drivers that support BIM within the wider context*

*Stakeholder engagement and BIM*

*Commercial arrangements and BIM*

*Risks associated to project or organisational BIM implementation*

*Return on investment and benchmarking across a BIM project*

**LO4 Assess ways in which the design and construction process of an asset influences the way that asset is managed and maintained**

*How Building Information Modelling can aid in the design, construction and operation of an asset*

*The difference between constructing and managing an asset*

*Whole life vs capital investment*

*The term Asset Information Model and its relationship to the project information*

*Updating information effectively for handover of an asset to a facilities management team*

*Storing, sharing and archiving data through all stages of a project*

*Managing data effectively to aid in the operational functions*

*The difference between capital expenditure and operational expenditure, and the difference between the two*

*Maintenance and operation*

*Consolidating information effectively across the in-use stages of a project*

*Roles and responsibilities associated with BIM*

*Challenges, changes and management.*

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Discuss the term Building Information Modelling in the context of local, national and global developments in the construction industry		<b>D1</b> Critically analyse the impact of Building Information Modelling on the construction industry and how it can positively affect both the capital and operational phase of a facility
<b>P1</b> Explain the term Building Information Modelling and how it relates to the construction industry  <b>P2</b> Discuss the key terms and definitions in regard to Building Information Modelling	<b>M1</b> Analyse the importance of Building Information Modelling in the construction industry.  <b>M2</b> Analyse the way that key terms and consistency of these terms should inform all members of a project team.	
<b>LO2</b> Describe the basic concepts surrounding Building Information Modelling		<b>D2</b> Critically evaluate and create a BIM Execution Plan and understand how BIM Dimensions can influence various elements of a building project
<b>P3</b> Discuss the key themes surrounding BIM  <b>P4</b> Explain the terms that support BIM Dimensions on a project	<b>M3</b> Analyse ways in which BIM can be utilised on a building project.	

Pass	Merit	Distinction
<p><b>LO3</b> Discuss the differences in purpose between Building Information Modelling and its associated outcomes, and traditional forms of construction information</p>		
<p><b>P5</b> Explore the key differences between traditional and Building Information Management (BIM) related processes in relation to construction</p> <p><b>P6</b> Discuss how collaborative working can aid and support a BIM process</p>	<p><b>M4</b> Analyse how BIM can inform a project outcome for the design team over and above traditional methods.</p>	<p><b>LO3 and LO4</b></p> <p><b>D3</b> Assess how a BIM-enabled process can result in positive outcomes for an asset owner, over and above traditional methods</p>
<p><b>LO4</b> Assess ways in which the design and construction process of an asset influences the way that asset is managed and maintained</p>		
<p><b>P7</b> Explain how information is created, managed and used through various stages of a project</p> <p><b>P8</b> Explain the roles that are required as part of a BIM-enabled project and how they aid in the development of the project at all stages</p>	<p><b>M5</b> Analyse ways in which BIM information is used, shared and managed.</p> <p><b>M6</b> Evaluate the roles required to successfully deliver a BIM project.</p>	

## Recommended Resources

### Textbooks

EASTMEN, C., TEICHOLZ, P., SACKS, R. and LISTON, K. (2011) *BIM handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors*. 2nd ed. Hoboken, New York: John Wiley & Sons Inc.

FAIRHEAD, R. (2013) *Information Exchanges: RIBA Plan of Work 2013 Guide*. London: RIBA Publishing.

HOLZER, D. (2016) *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering and Construction*. Hoboken, New Jersey: John Wiley & Sons Inc.

MORDUE, S., PHILP, D. and SWADDLE, P. (2015) *Building Information Modelling for Dummies*. Hoboken, New Jersey: John Wiley & Sons Inc.

SAXON, R. (2016) *BIM for Construction Clients*. London: RIBA Publishers.

SHEPHERD, D. (2015) *BIM Management Handbook*. London: RIBA Publishers.

### Websites

<a href="http://www.theb1m.com">www.theb1m.com</a>	The B1M (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group COBie UK 2012 (General Reference)
<a href="http://www.thenbs.com">www.thenbs.com</a>	NBS BIM (Building Information Modelling) (General Reference)

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 4: Construction Practice & Management*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 36: Advanced Building Information Modelling*

*Unit 47: Construction Data Management*

# Unit 15: Principles of Refurbishment

<b>Unit code</b>	<b>T/615/1401</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

There are buildings all over the world of different types, styles, ages and conditions. Once a building has been built there comes a need to maintain and update the property; to keep it fit for the intended purpose. Refurbishment is a broad term that covers adaptation, alteration and extension. The value of refurbishment to the construction industry is significant; with nearly half of the total value of construction coming from work to existing buildings. With a reduction of available land, legislative changes, and a drive for increased sustainability, the need to understand refurbishment has never been as prevalent as it is today.

This unit will allow students an opportunity to analyse the underpinning concepts of refurbishment and the options available. Students will be able to use construction knowledge from other units and apply it to a refurbishment project, taking into account the key factors that influence a scheme.

On successful completion of this unit students will be able to assess the suitability of a property for refurbishment, taking into consideration all applicable factors. The knowledge gained from the unit will be beneficial to those working in all aspects of the industry as a successful refurbishment project requires skills from all disciplines.

## **Learning Outcomes**

By the end of this unit, a student will be able to:

- 1 Explain the need for refurbishment
- 2 Compare different options for refurbishment projects
- 3 Analyse the refurbishment process
- 4 Prepare a proposal for a refurbishment scheme.

## Essential Content

### LO1 Explain the need for refurbishment

*Need for refurbishment:*

Ageing property stock

Obsolescence (economic, functional, physical, social, legal)

Demographic changes

Legislative changes

Deterioration of the fabric

Preservation of the historic environment

Decline in performance

Environmental and sustainability needs

Societal trends.

### LO2 Compare different options for refurbishment projects

*Scale of refurbishment options:*

Small: minor upgrades of the fabric and small-scale lateral extensions

Medium: major upgrades, larger lateral and vertical extensions, radical internal changes and alterations

Large: extensive alterations, upgrades and extensions (e.g. additional storey above or below ground), façade retention etc.

*Level of interventions:*

Preservation

Conservation

Refurbishment

Rehabilitation

Renovation

Remodelling

Restoration

Demolition.



### LO3 **Analyse the refurbishment process**

#### *Process of refurbishment:*

Identification of need

Initial survey/inspection to ascertain the basic details of the property

Feasibility

Detailed survey (structural appraisal and diagnosis of faults)

Evaluation and options

Detailed scheme design

Legal considerations (planning, building regulations etc.)

Tender

Construction

Handover.

#### *Occupancy*

### LO4 **Prepare a proposal for a refurbishment scheme**

#### *Designing for refurbishment:*

Analysis of existing drawings and survey reports

Understanding structural reports

Interpretation of the client brief

Preparation of outline schemes

Budget costs and approximate estimating

Detailed drawings and specifications

Legislative compliance.

#### *Evaluate refurbishment schemes:*

Evaluate existing schemes and propose alternative arrangements

Review drawings and specifications and propose suitable alternatives.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Explain the need for refurbishment		<b>LO1, LO2, and LO3</b> <b>D1</b> Evaluate the refurbishment process and the options available in terms of societal need, environmental impact, time, cost and quality
<b>P1</b> Explain why properties will require refurbishment throughout their lifecycle  <b>P2</b> Discuss economic, functional, physical, social, and legal obsolescence  <b>P3</b> Explain the benefits and challenges of refurbishment in regard to sustainability	<b>M1</b> Compare different forms of obsolescence and how they may contribute to the need for refurbishment	
<b>LO2</b> Compare different options for refurbishment projects		
<b>P4</b> Illustrate the different levels of refurbishment intervention  <b>P5</b> Explain the scale of refurbishment options	<b>M2</b> Analyse a range of refurbishment options and interventions for a given scenario	
<b>LO3</b> Analyse the refurbishment process		
<b>P6</b> Analyse the refurbishment process  <b>P7</b> Discuss the processes of planning and building regulations approval in relation to refurbishment	<b>M3</b> Analyse the stages of a refurbishment project and discuss the interrelationship between them	

Pass	Merit	Distinction
<b>LO4</b> Prepare a proposal for a refurbishment scheme		<b>D2</b> Justify a refurbishment proposal, highlighting how it addresses issues of obsolescence
<b>P8</b> Interpret a given scenario and produce outline drawings for a refurbishment scheme	<b>M4</b> Produce detailed working drawings and specification	
<b>P9</b> Produce an outline specification and budget costs for a refurbishment scheme		
<b>P10</b> Prepare building regulation and planning application documentation for a refurbishment scheme		

## Recommended resources

### Textbook

BAKER, N. (2009) *The Handbook of Sustainable Refurbishment: Non-Domestic Buildings*. Abingdon: Routledge.

FORSYTH, M. (2007) *Structures and Construction in Historic Building Conservation*. London: Wiley-Blackwell.

GLOVER, P. V. (2013) *Building Surveys*. Abingdon: Routledge.

HIGHFIELD, D. (2009) *Refurbishment and Upgrading Buildings*. New York: Spon Press.

HOXLEY, M. (2009) *Good Practice Guide: Building Condition Surveys*. London: RIBA Publishing.

HOXLEY, M. (2016) *Building Condition Surveys*. London: RIBA Publishing.

NOY, E.A., and DOUGLAS, J. (2011) *Building Surveys and Reports*. London: Wiley-Blackwell.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 35: Alternative Methods of Construction*

*Unit 41: Surveying for Conservation, Renovation & Refurbishment*

# Unit 16: Principles of Alternative Energy

<b>Unit code</b>	<b>A/615/1402</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

Buildings use about 40% of global energy, 25% of global water and 40% of global resources in their construction and operation. Governments around the world have recognised the importance of tackling energy consumption in the built environment, and have instituted legislation to address these issues. These have often been supported by financial incentives to implement alternative energy systems and processes. They are also governed by rigorous targets and deadlines. Technologies that harness solar, wind and hydro energy are now established systems for generating power and heat. Along with other innovations such as heat pumps and bio-fuel, these are often incorporated into the design for new construction projects.

The aim of this unit is to develop the students' knowledge of current and future energy technologies and to apply that knowledge in analysis and assessment of its effectiveness. Students will also be called upon to apply that knowledge and research to a design activity.

On successful completion of this unit students will be able to research and design alternative energy systems and assess new technologies available to the construction industry.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Discuss types of alternative energy system, and how they differ from common systems in use today
- 2 Evaluate the factors that inform the selection of a renewable energy system in relation to a specific installation
- 3 Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy
- 4 Describe ways in which different forms of alternative energy address broader environmental issues and provide sustainable solutions.

## Essential content

### LO1 **Discuss types of alternative energy system, and how they differ from common systems in use today**

#### *Existing technologies:*

Photovoltaic systems

Wind turbines

Hydro-electrical systems

Combined heat and power

Heat pumps

Solar heating

Biomass

Water re-use.

#### *Advances in construction, installation and maintenance of renewable energy hardware:*

Robotics, used for installation, maintenance and optimisation

Optical furnaces, printable solar panels

Liquid metal batteries

Advances in wave power

Sun-tracking solar cells, solar energy harvesting from space

Hydrogen cell technology.

### LO2 **Evaluate the factors that inform the selection of a renewable energy system in relation to a specific installation**

#### *External factors:*

Effects of weather, light availability and quality

Presence of natural resources needed to drive the system

Political and aesthetic factors, local feeling, planning permissions, regulatory issues.

*Technical and design factors:*

Client requirements, building structure, access, power output (both electrical and heating), electrical and mechanical components and regulatory requirements.

*Cost factors:*

Tariffs and tariff calculations, alternative energy installation costs vs cumulative savings.

**LO3 Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy**

*Monitoring:*

Methods of monitoring cost, developing a cost-to-saving paradigm

Methods of monitoring the energy production and savings for the scheme.

*Data gathering:*

Customer requirements, specification, method statement, project planning.

*Installation:*

Installation methods for renewable systems.

**LO4 Describe ways in which different forms of alternative energy address broader environmental issues and provide sustainable solutions**

*Political:*

Kyoto Agreement, global targets, regional targets, carbon trading.

*Environmental:*

Effects of CO<sub>2</sub> emissions, greenhouse effect, waste products and management, health issues.

*Sustainability:*

Projections for availability of non-renewable resources

Hidden sustainability and environmental cost of renewables: manufacture, transportation, installation.



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Discuss types of alternative energy system, and how they differ from common systems in use today		<b>D1</b> Analyse current and advanced renewable technologies, evaluating their effectiveness and impact on the environment as compared to existing non-renewable technologies
<b>P1</b> Explain the operating principles and purpose of the main types of renewable energy technology in current use  <b>P2</b> Compare renewable technologies to existing non-renewable energy systems	<b>M1</b> Analyse the operating principles, and environmental impact of, existing and advanced renewable technologies.	
<b>LO2</b> Evaluate the factors that inform the selection of a renewable energy system in relation to a specific installation		<b>LO2</b> Evaluate the factors that inform the selection of a renewable energy system in relation to a specific installation
<b>P3</b> Evaluate the factors affecting the selection of a renewable energy system  <b>P4</b> Describe advances in renewable energy technology and how they meet the needs of a specific installation	<b>M2</b> Justify the selection of a renewable energy system.	
<b>LO3</b> Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy		
<b>P5</b> Select appropriate renewable technology system for an existing building  <b>P6</b> Present a strategy, for an existing building, to integrate a form of alternative energy	<b>M3</b> Justify design decisions based on external, cost and design factors.	

Pass	Merit	Distinction
<b>LO4</b> Describe ways in which different forms of alternative energy address broader environmental issues and provide sustainable solutions		
<b>P7</b> Describe ways alternative energy technology addresses broader environmental issues	<b>M4</b> Compare how different environmental technologies address broader environmental and sustainability issues.	<b>D3</b> Analyse how specific renewable technologies meet the requirements of environmental initiatives such as the Kyoto Protocol, carbon trading and global and local government targets

## Recommended resources

### Textbooks

DUFFY, A., ROGERS, M. and AYOMPE, L. (2015) *Renewable Energy and Energy Efficiency: Assessment of Projects and Policies*. 1st ed. Chichester: John Wiley & Sons.

GRINNELL, S. (2016) *Renewable Energy & Sustainable Design*. 1st ed. Boston: Cengage.

TWIDELL, J. and WEIR, T. (2015) *Renewable Energy Resources*. 3rd ed. Abingdon: Routledge.

### Websites

[www.altenergy.org](http://www.altenergy.org)

Alternative Energy  
(General Reference)

[www.therenewableenergycentre.co.uk](http://www.therenewableenergycentre.co.uk)

The Renewable Energy Centre  
(General Reference)

### Links

This unit links to the following related units:

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 19: Principles of Electrical Design & Installation*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 33: Advanced Electrical Design & Installation*

*Unit 40: Alternative Energy Systems Design & Installation*

# Unit 17: Principles of Public Health Engineering

<b>Unit code</b>	<b>F/615/1403</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The role of a public health engineer is a very important and diverse one in the construction process. They design systems for water supply and sanitation that help buildings work better for occupants, owners and the environment. This may vary from a drainage system in a hospital to a water supply system in a high-rise apartment building.

This unit introduces students to the principles of public health engineering. Students will develop a broad understanding of domestic hot and cold water services, sanitation and rainwater systems that serve large commercial and complex multi-zone buildings.

On successful completion of this unit students will be able to calculate, design and select appropriate pipework systems and plantroom equipment for hot and cold water services, sanitation and rainwater systems for large commercial buildings.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Explain the different types of domestic water services systems and above ground drainage that serve large commercial and complex buildings
- 2 Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment
- 3 Develop sustainable design strategies for public health engineering
- 4 Design and specify water and sanitation services for large non-domestic buildings.

## Essential content

### LO1 Explain the different types of domestic water services systems and above ground drainage that serve large commercial and complex buildings

#### *Cold water:*

Sources of water: water quality, hardness, water treatment, corrosion

Distribution systems: direct and indirect systems, boosted cold water systems, water storage, pressure reduction and control, domestic sprinkler systems.

#### *Hot water:*

Hot water production: local vs central, vented and unvented, calorifiers, plate heat exchangers, local heaters

Distribution systems; secondary circulation, pumps and balancing, trace heating, avoidance of dead legs.

#### *Above ground drainage:*

Sanitary pipework systems: attributes, primary ventilated stack system, secondary ventilated stack system, ventilated and unventilated branches, stub stacks, pumped drainage systems

Kitchen and laboratory drainage.

#### *Rainwater systems:*

Rainwater pipework systems: gravity and siphonic systems, gutters and roof outlets, paved area drainage, sound attenuation, soakaways.

## LO2 **Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment**

### *Cold water:*

Water regulations, categories of fluid, contamination risks, air gaps and backflow prevention, legionella prevention and monitoring, disinfection and flushing of systems, British Standards and codes of practice, commissioning and maintenance.

### *Hot water:*

Legionella prevention, thermal balancing, hot water temperatures, legionella prevention vs scalding, building regulations, mixers and blending of hot water, thermostatic control, safety features for unvented hot water.

### *Above ground drainage:*

Limits of stack system, trap seal loss, high rise building drainage, invert levels, secondary venting, air admittance valves (AAV), positive air pressure attenuators (PAPA), offsets and vent termination. Sewer capacities

Building regulations and codes of practice.

### *Rainwater systems:*

Green, brown and blue roofs, pitched roof types, rainfall intensities, Sustainable Urban Drainage Systems (SUDS), rainwater attenuation.

### *Building regulations and codes of practice*

## LO3 **Develop sustainable design strategies for public health engineering**

### *BREEAM and LEED*

Water flow rates and leak detection methods: requirements and solutions

Water consumption and water conservation measures: types and techniques

Hot water generation: Combined Heat and Power (CHP) overview and solar thermal overview

Grey water recycling systems: benefits and pitfalls

Rainwater harvesting systems: requirements and uses.

#### **LO4 Design and specify water and sanitation services for large non-domestic buildings**

##### *Cold water systems:*

Cold water storage requirements, cistern sizing, probability theory and loading units, cold water pipe sizing, pressure, flow rates and velocity, booster set sizing.

##### *Hot water systems:*

Hot water generator sizing, reheat/recovery period, storage, semi-storage or instantaneous, hot water flow and return pipe sizing, circulating pump size, mass flow rate and pressure drop.

##### *Above ground drainage systems:*

Stack and drain sizing, invert level calculations and relevant falls of pipework.

##### *Rainwater systems:*

Surface water run-off calculations, storm return periods/rainfall intensities, gutter and roof outlet sizing, attenuation tank sizing.



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Explain the different types of domestic water services systems and above ground drainage that serve large commercial and complex buildings</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Critically analyse different water and sanitation systems and plant choices, explaining how such choices may impact on the building's construction and performance</p>
<p><b>P1</b> Identify the main hot &amp; cold water and sanitation systems for commercial buildings</p> <p><b>P2</b> Describe the main plant items for water and sanitation systems</p>	<p><b>M1</b> Illustrate the operation of a hot &amp; cold water and sanitation system for a given building type</p>	
<p><b>LO2</b> Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment</p>		
<p><b>P3</b> Explain the current legislation and codes of practice that influence the design and selection of water and sanitation systems</p> <p><b>P4</b> Identify relevant design fundamentals that are needed in order to undertake the design of water and sanitation schemes for buildings</p>	<p><b>M2</b> Analyse the relationship between design fundamentals and legislative requirements needed for an effective public health design of a building</p>	

Pass	Merit	Distinction
<p><b>LO3</b> Develop sustainable design strategies for public health engineering</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Evaluate the impact of incorporating a sustainable public health scheme within a building design</p>
<p><b>P5</b> Identify the main drivers, both economic and legislative, for sustainable design in public health engineering</p> <p><b>P6</b> Produce a design strategy for a public health engineering installation in a given context</p>	<p><b>M3</b> Compare sustainable design strategies for public health engineering in relation to a given context</p>	
<p><b>LO4</b> Design and specify water and sanitation services for large non-domestic buildings</p>		
<p><b>P7</b> Explain the parameters that inform the design of public health engineering services for a building</p> <p><b>P8</b> Produce drawings and specification for water and sanitation services in a large non-domestic building</p>	<p><b>M4</b> Calculate the required plant and pipe sizes for a public health engineering design</p>	

## Recommended resources

### Textbooks

BUTLER, D. and DAVIES, J. (2010) *Urban Drainage*. 3rd ed. London: Spon Press.

CHADDERTON, D. (2012) *Building Services Engineering*. 6th ed. London: Routledge.

CIBSE (2014) *CIBSE Guide G: Public Health and Plumbing Engineering*. London: Chartered Institution of Building Services Engineers.

GARRETT, R.H. (2008) *Hot and Cold Water Supply*. 3rd ed. Chichester, West Sussex: Wiley-Blackwell.

HALL, F. and GREENO, R. (2015) *Building Services Handbook*. 8th ed. London: Routledge.

CHARTERED INSTITUTE OF PLUMBING AND HEATING DESIGN (2002) *Plumbing Engineering Services Design Guide*. Hornchurch, Essex: CIPHE.

WATER REGULATIONS ADVISORY SCHEME (WRAS) (2000) *Water Regulations Guide*. 2nd ed. Gwent: WRAS.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 43: Hydraulics*

# Unit 18: Civil Engineering Technology

<b>Unit code</b>	<b>J/615/1404</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

This unit explores the role of professional civil engineers, their essential involvement in the construction and maintenance of infrastructure, and the key technologies they apply. The technologies and processes of civil engineering, in the development of highways, bridges, drainage systems, substructure and superstructure, are crucial to support contemporary societies.

Topics included in this unit are: earthwork activities, temporary and permanent dewatering procedures, methods and techniques used to create substructures, highways and superstructures and the common hazards, technical problems and solutions associated with modern civil engineering activities.

On successful completion of this unit students will be able to describe, analyse and evaluate modern civil engineering procedures, apply this skill and knowledge to the design of infrastructure and produce solutions to address hazards and problems encountered in civil engineering projects.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Explain the methods and techniques used in civil engineering for earthworks and substructures
- 2 Present a site safety plan, risk assessment and method statement for a given civil engineering activity
- 3 Evaluate a given civil engineering problem and propose a solution
- 4 Prepare a design proposal for a new infrastructure project.

## Essential content

### LO1 Explain the methods and techniques used in civil engineering for earthworks and substructures

*Earthworks activities, use and specification of earthmoving equipment*

*Formation of cuttings and embankments:*

Groundwater problems and techniques used to deal with issues of ground and slope stability

Temporary and permanent dewatering techniques

Techniques used in deep excavations and trenching works

Methods and techniques used to create complex foundations

Methods and techniques used in piling works

Methods and techniques used in drainage works

Methods and techniques used in culvert construction

Methods and techniques used in underpasses and utilities.

### LO2 Present a site safety plan, risk assessment and method statement report for a given civil engineering activity

*Health & safety legislation and codes of practice relative to civil engineering site activities, hazards, risks and safety arrangements for excavations:*

Hazards, risks and safety arrangements for working in confined spaces

Hazards, risks and safety arrangements for working on structures

Hazards, risks and safety arrangements for working within temporary works on highways

Roles and responsibilities of all parties in civil engineering projects.

*Site safety plans*

### **LO3 Evaluate a given civil engineering problem and propose a solution**

*Civil engineering environmental contexts*

*Civil engineering quality contexts*

*Civil engineering geotechnical contexts*

*Civil engineering economic contexts*

### **LO4 Prepare a design proposal for a new infrastructure project**

*Methods and techniques used to create bridges and the different specifications of bridges:*

Flexible highway construction foundation criteria and related geotechnical parameters

Methods and techniques used to create flexible highways

Methods and techniques used in highway link and junction design

Methods and techniques used in flexible pavement design.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Explain the common methods and techniques used in civil engineering earthworks and substructures		<b>D1</b> Evaluate methods and techniques used to deal with issues of ground and slope stability
<b>P1</b> Discuss earthworks activities, equipment and techniques  <b>P2</b> Describe methods and techniques used to create complex foundations, piling works and drainage works  <b>P3</b> Describe methods and techniques used in culvert construction, underpass construction and provision for utilities	<b>M1</b> Analyse methods and techniques used in large complex earthmoving operations and deep excavations	
<b>LO2</b> Present a site safety plan, risk assessment and method statement for a given civil engineering activity		<b>D2</b> Justify a site safety plan, risk assessments and method statements report for activities related to a given civil engineering project
<b>P4</b> Identify the hazards, risks and safety arrangements for excavations, working in confined spaces, working on structures and for working within temporary works on highways  <b>P5</b> Develop and present a site safety plan, risk assessments and method statements for a given civil engineering activity	<b>M2</b> Discuss Health & Safety legislation and codes of practice related to civil engineering sites	



Pass	Merit	Distinction
<p><b>L03</b> Evaluate a given civil engineering problem and propose a solution</p>		<p><b>L03 and L04</b></p> <p><b>D3</b> Justify the selection of specific features in the development of a civil engineering solution to a given problem</p>
<p><b>P6</b> Evaluate the environmental, quality, geotechnical and economic contexts of a given civil engineering problem</p> <p><b>P7</b> Propose a solution to a given civil engineering problem</p>	<p><b>M3</b> Illustrate how the environmental, geotechnical, quality and economic contexts of a problem are addressed through a proposal</p>	
<p><b>L04</b> Prepare a design proposal for a new infrastructure project</p>		
<p><b>P8</b> Describe methods and techniques used in highway design</p> <p><b>P9</b> Develop a civil engineering design proposal for a new infrastructure project</p>	<p><b>M4</b> Analyse methods and techniques used to create bridge foundations, flexible highway construction foundation criteria and related geotechnical parameters</p>	

## Recommended resources

### Textbooks

CHUDLEY, R. and GREENO, R. (2012) *Advanced Construction Technology*. 5th ed. Harlow: Pearson.

CHUDLEY, R. and GREENO, R. (2014) *Building Construction Handbook*. 10th ed. Oxford: Butterworth-Heinemann.

MANLEY, S., CHARTERS, M., FRANCIS, C., TOPLISS, S. and DOYLE, M. (2008) *Construction*. Harlow: Pearson.

ROGERS, M. and ENRIGHT, B. (2016) *Highway Engineering*. 3rd ed. Oxford: John Wiley & Sons.

### Websites

<a href="http://www.standardsforhighways.co.uk">www.standardsforhighways.co.uk</a>	Standards for Highways (General Reference)
<a href="http://www.ice.org.uk">www.ice.org.uk</a>	Institution of Civil Engineers (General Reference)
<a href="http://www.icevirtuallibrary.com">www.icevirtuallibrary.com</a>	Institution of Civil Engineers 'Virtual Library' (General Reference)

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 8: Mathematics for Construction*

*Unit 14: Building Information Modelling*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 27: Construction Technology for Complex Building Projects*

*Unit 30: Advanced Structural Design*

*Unit 36: Advanced Building Information Modelling*

*Unit 42: Highway Engineering*

# Unit 19: Principles of Electrical Design & Installation

<b>Unit code</b>	<b>L/615/1405</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

While people have studied electricity since the 17th century, and had an awareness of the phenomenon as early as the 3rd millennium BCE, it was the 20th century that saw the rapid expansion of electrical devices and installation that has defined modern society. No longer limited to the presence of natural light, we are able to work, play and enjoy activities at any time. The availability of electrical current, to almost any location, has also led to a proliferation of devices that make many mundane tasks simple.

This unit aims to provide the students with a broad understanding of electrical machines, distribution of electric energy and lighting design basics. This unit develops the skills needed to design simple electrical and lighting installations in compliance with relevant legislation and standards.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Discuss the fundamentals of electricity, magnetism, transformers and circuits
- 2 Analyse the performance, operation and control of AC and DC motors
- 3 Explain the different methods of electricity distribution
- 4 Prepare a proposal for a non-domestic lighting installation.

## Essential content

### LO1 Discuss the fundamentals of electricity, magnetism, transformers and circuits

*Magnetic circuits*

*Electric circuits*

*Transformers*

*Health & safety legislation*

### LO2 Analyse the performance, operation and control of AC and DC motors

*DC motor circuits*

*AC motor circuits*

*Operating characteristics of AC and DC motors*

*Motor selection and specification*

### LO3 Explain the different methods of electricity distribution

*Types of loads*

*Calculations for assessing electrical load*

*Alternative power supplies*

*Applications, characteristics and features of Uninterruptible Power Supply (UPS) systems*

*Methods of electricity distribution*

*National and local regulations*

*Health & safety legislation*

### LO4 Prepare a proposal for a non-domestic lighting installation

*Types of lamps and luminaries*

*Selection and specification of lamps and luminaries*

*Efficacy and energy design requirements of lighting installations*

*General and emergency lighting installations*

*National and local regulations*

*Health & safety legislation.*

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Discuss the fundamentals of electricity, magnetism, transformers and circuits		<b>D1</b> Evaluate electrical and magnetic circuits for a given non-domestic installation
<p><b>P1</b> Explain the performance of electrical and magnetic circuits, including transformers</p> <p><b>P2</b> Assess the Health &amp; Safety issues associated with electrical and magnetic circuits</p>	<b>M1</b> Design a simple electrical circuit for a given non-domestic building	
<b>LO2</b> Analyse the performance, operation and control of AC and DC motors		<b>D2</b> Compare the suitability of AC and DC motors for a given context
<p><b>P3</b> Analyse the principles that underpin the operation and control of AC and DC motors</p> <p><b>P4</b> Calculate the performance of AC and DC motors</p>	<b>M2</b> Select a motor, based on performance needs, for a given non-domestic application	
<b>LO3</b> Explain the different methods of electricity distribution		<b>LO3 and LO4</b> <b>D3</b> Evaluate the relationship between lighting design and electrical circuit design for a non-domestic installation
<p><b>P5</b> Explain different methods of electricity distribution</p> <p><b>P6</b> Describe the equipment used for different methods of electrical distribution</p>	<b>M3</b> Calculate the electrical load for a given non-domestic building, in order to select a suitable distribution panel	
<b>LO4</b> Prepare a proposal for a non-domestic lighting installation		
<p><b>P7</b> Discuss the principles that underpin the design and installation requirements of lighting applications</p> <p><b>P8</b> Produce drawings and details for electricity distribution and lighting for a non-domestic installation</p>	<b>M4</b> Illustrate circuits and distribution as part of a design proposal	

## Recommended resources

### Textbooks

- CATHEY, J.J. (2001) *Electric Machines: Analysis and Design Applying MATLAB*. London: McGraw-Hill.
- CHAPMAN, S.J. (2002) *Electrical Machinery and Power System Fundamentals*. London: McGraw-Hill.
- GURU, B.S. and HIZIROGLU, H.R. (2000) *Electric Machinery and Transformers*. 3rd ed. Oxford: Oxford University Press.
- HAMBLEY, A.R. (2007) *Electrical Engineering: Principles and Applications*. 4th ed. London: Prentice Hall.
- KARLEN, M., BENYA, J.R. and SPANGLER, C. (2012) *Lighting Design Basics*. 2nd ed. Oxford: John Wiley & Sons.
- LICHT, U.B. (2006) *Detail Practice: Lighting Design: Principles, Implementation, Case Studies (Detail Practice Series)*. Basel: Birkhäuser GmbH.
- NISE, N.S. (2004) *Control Systems Engineering*. 4th ed. Oxford: John Wiley.
- WILDE, T. (2006) *Electrical Machines, Drives and Power Systems*. 6th ed. Harlow: Pearson International Edition.

### Links

This unit links to the following related units:

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 8: Mathematics for Construction*

*Unit 14: Building Information Modelling*

*Unit 16: Principles of Alternative Energy*

*Unit 28: Further Mathematics for Construction*

*Unit 33: Advanced Electrical Design & Installation*

*Unit 40: Alternative Energy Systems Design & Installation*

## Unit 20: Principles of Structural Design

<b>Unit code</b>	<b>R/615/1406</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

### Introduction

Buildings, bridges, roads, and many other types of man-made structures are critical to the economic and social well-being of our societies. We rely upon these structures to provide us with suitable spaces and infrastructure to support our daily lives. This unit explores the fundamental principles of structural design, codes of practice and standards required to construct safe, effective static civil engineering structures commonly used in today's infrastructure projects.

Topics included in this unit are: methods and techniques used to determine bending moments and shear forces in simply supported steel and reinforced concrete beams; deflection in simply supported steel beams; and axial load carrying capacity of steel and reinforced concrete columns.

On successful completion of this unit students will be able to determine and analyse forces within fixed structures and understand the fundamental concepts of structural design.



## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Calculate bending moments and shear forces for simply supported steel and concrete beams
- 2 Determine deflection for simply supported steel beams
- 3 Calculate the axial load carrying capacity of steel and reinforced concrete columns
- 4 Explore design methods for steel, reinforced concrete beams and columns.

## Essential content

### LO1 Calculate bending moments and shear forces for simply supported steel and concrete beams

#### *Loading:*

Dead loads

Live loads

Wind loads

Point loads

Uniformly distributed loads.

#### *Elasticity and plasticity of common construction materials:*

Factors of safety

Building regulations

Health & safety regulations.

#### *Bending moments:*

Bending moment diagrams.

#### *Shear forces:*

Shear force diagrams.

### LO2 Determine deflection for simply supported steel beams

*Deflection in supported beams with point loads*

*Deflection in supported beams with uniformly distributed loading*

**LO3 Calculate the axial load carrying capacity of steel and reinforced concrete columns**

*Axial loading:*

Steel columns

Reinforced concrete columns

Foundations

*Slenderness ratio*

*Effective length*

*Material properties*

*Corrosion resistance*

*Weathering*

**LO4 Explore design methods for steel, reinforced concrete beams and columns**

*Limit state design*

*Steel:*

Beam design and selection

Column design and selection.

*Reinforced concrete:*

Beam design and selection

Column design and selection

Building Information Modelling for structures.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Calculate bending moments and shear forces for simply supported steel and concrete beams		<b>D1</b> Evaluate how maximum bending moments determine steel beam selection using current codes of practice and approved documents in terms of economics and safety
<p><b>P1</b> Determine the following by calculations and diagrams: bending moments and shear force in simply supported steel beams with point loads and uniformly distributed loads</p> <p><b>P2</b> Discuss the statutory requirements to ensure safety in structural designs</p>	<b>M1</b> Produce valid factors of safety for live loads, dead loads and imposed loads using current codes of practice and building regulations	
<b>LO2</b> Determine deflection for simply supported steel beams		<b>LO2 and LO3</b> <b>D2</b> Assess the most effective support method for a given scenario, in terms of ease and speed of construction, economics, safety and environmental factors
<p><b>P3</b> Determine deflection in simply supported steel beams with point loads and a uniformly distributed load</p> <p><b>P4</b> Explain how deflection in beams affects structural stability</p>	<b>M2</b> Analyse different support methods and their effect on deflection in fixed structures	
<b>LO3</b> Calculate the axial load carrying capacity of steel and reinforced concrete columns		
<p><b>P5</b> Describe the concepts of slenderness ratio and effective length</p> <p><b>P6</b> Determine the axial load carrying capacity of steel columns and reinforced concrete columns</p>	<b>M3</b> Analyse the load carrying capacity, size, weight and corrosion resistance properties of different materials used for beams and columns in fixed structures	

Pass	Merit	Distinction
<b>LO4</b> Explore design methods for steel, reinforced concrete beams and columns		<b>D3</b> Assess the use of Building Information Modelling in the production of accurate structural design information and the collaborative environment of structural design
<b>P7</b> Develop a design solution, including beam design and column design, for a given scenario  <b>P8</b> Produce drawings and specifications in support of a structural design solution	<b>M4</b> Evaluate the use of an alternative material in achieving a design solution, discussing the benefits or challenges associated	

## Recommended resources

### Textbooks

- ANTHONY, A. et al (2007) *Reynolds's Reinforced Concrete Designer's Handbook*. 11th ed. Abingdon: Taylor & Francis.
- DURKA, F. et al (2002) *Structural Mechanics: Loads, Analysis, Design and Materials*. 6th ed. London: Prentice Hall.
- FIONA, C. (2008) *Structural Engineer's Pocket Book*. 2nd ed. Oxford: Butterworth-Heinemann.
- HULSE, R. and CAIN, J. (2000) *Structural Mechanics*. 2nd ed. London: Palgrave Macmillan.
- MCKENZIE, W. (2003) *Design of Structural Elements*. London: Palgrave Macmillan.
- MOSLEY, H. (2007) *Reinforced Concrete Design*. 6th ed. London: Palgrave.
- OZELTON, E. (2006) *Timber Designers' Manual*. Chichester, West Sussex: Wiley-Blackwell.
- SEWARD, D. (2003) *Understanding Structures: Analysis, Materials, Design*. 3rd ed. London: Palgrave Macmillan.
- SMITH, P. (2001) *An Introduction to Structural Mechanics*. London: Palgrave Macmillan.
- Steel Construction Institute (2005) *Steel Design Manual*. 6th ed. Chichester, West Sussex: Wiley-Blackwell.

### Websites

- |  |   |
|--|---|
| <a href="http://www.ice.org.uk">www.ice.org.uk</a>     | Institution of Civil Engineers<br>(General Reference)                                     |
| <a href="http://www.istructe.org">www.istructe.org</a> | The Institution of Structural Engineers<br>(General Reference)                            |
| <a href="http://www.iabse.org">www.iabse.org</a>       | International Association for Bridge and<br>Structural Engineering<br>(General Reference) |
| <a href="http://www.cices.org">www.cices.org</a>       | Chartered Institution of Civil Engineering<br>Surveyors<br>(General Reference)            |

## **Links**

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 8: Mathematics for Construction*

*Unit 14: Building Information Modelling*

*Unit 18: Civil Engineering Technology*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 28: Further Mathematics for Construction*

*Unit 29: Geotechnics & Soil Mechanics*

*Unit 35: Alternative Methods of Construction*

*Unit 36: Advanced Building Information Modelling*

*Unit 42: Highway Engineering*

*Unit 46: Advanced Materials*

# Unit 21: Site Supervision & Operations

<b>Unit code</b>	<b>Y/615/1407</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The construction of buildings and infrastructure involves many different types of work and many different people. The skills required to successfully manage the diverse groups of people on a building site, and to monitor and assess their work, is critical to both the success of the project and to ensure the safety of those working.

Through this unit students will develop the skills and techniques necessary to manage the people and processes of a building site, ensuring the quality of work, safe working practices and the interactions of different 'trades'.

Topics covered in this unit include: evaluating construction information, monitoring quality, identifying and notifying of defects, sustainable methods of construction, site safety regulations, Health & Safety regulations, people management, performance management, site meetings, contractor and sub-contractor relations.



## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Evaluate construction information to determine quality requirements
- 2 Prepare a report on defects and recommended remedial actions
- 3 Assess a pre-construction Health & Safety plan for a given construction project, in relation to local and national regulations
- 4 Discuss methods for evaluating and improving the performance of site staff.

## Essential content

### LO1 Evaluate construction information to determine quality requirements

*Construction information:*

Construction drawings

Specifications

Schedules

Building Information Modelling.

*Statutory documents related to quality:*

Building regulations

Health & safety regulations.

### LO2 Prepare a report on defects and recommended remedial actions

*Site visits and evaluation:*

Patent defects

Latent defects

'Walking the site'

Identifying defects

Recording defects

Notifying defects.

*On-site testing/off-site testing:*

Prototypes

Mock-ups

Testing facilities

Quality certification systems.

*Quality control responsibilities:*

Architect

Civil engineer

Clerk of works

Contractors/sub-contractors

Site staff.

**LO3 Assess a pre-construction Health & Safety plan for a given construction project, in relation to local and national regulations**

*Construction design management:*

Client responsibilities

Professional responsibilities

Information recording and sharing.

*Statutory health & safety requirements:*

Site safety monitoring

Responsibilities

Notifications.

*Risk assessment and management*

#### LO4 **Discuss methods for evaluating and improving the performance of site staff**

*Working relationships:*

Effective communication

Motivation

Managing conflict

Equality and diversity.

*Performance monitoring and evaluation:*

Supervision and supervisors

Target setting

Review

Self-evaluation

Supervisor evaluation

Peer evaluation

Training and development needs.

*Site manager responsibilities:*

Leadership techniques

Identifying staff training needs

Training and development planning

Continuing Professional Development.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Evaluate construction information to determine quality requirements		<b>LO1 and LO2</b>  <b>D1</b> Review construction information and schedules of defects to ascertain patent defects and the implication for defects liability
<b>P1</b> Define quality requirements for a given project through the review of drawings, specifications and schedules  <b>P2</b> Explore the relationship between project quality requirements with statutory requirements	<b>M1</b> Evaluate the impact of potential changes in project quality requirements that are necessary to meet statutory requirements	
<b>LO2</b> Prepare a report on defects and recommended remedial actions		
<b>P3</b> Identify defects for a given construction project and produce a schedule of defects  <b>P4</b> Explore remedial actions necessary to address identified defects	<b>M2</b> Discuss the difference between patent and latent defects and their associated implications for remedial actions	

Pass	Merit	Distinction
<p><b>LO3</b> Assess a pre-construction Health &amp; Safety plan for a given construction project, in relation to local and national regulations</p>		<p><b>D2</b> Give examples of methods for promoting a positive approach to Health &amp; Safety for a construction team</p>
<p><b>P5</b> Discuss the importance of construction design management for ensuring site safety</p> <p><b>P6</b> Discuss local and national requirements for Health &amp; Safety in relation to construction projects</p>	<p><b>M3</b> Evaluate the impact of Health &amp; Safety violations on construction projects</p>	
<p><b>LO4</b> Discuss methods for evaluating and improving the performance of site staff</p>		<p><b>D3</b> Analyse the relationship between performance management and Health &amp; Safety legislation</p>
<p><b>P7</b> Describe the methods for evaluating the performance of team members</p> <p><b>P8</b> Recommend training and development strategies to improve performance</p>	<p><b>M4</b> Evaluate the relationship between equality and diversity and performance management in the construction industry</p>	

## Recommended resources

### Textbooks

BARBER, J. and INSTITUTION OF CIVIL ENGINEERS (2002) *Health & Safety in Construction: Guidance for Construction Professionals*. London: Thomas Telford.

CHARTERED INSTITUTE OF BUILDING (2014) *Code of Practice for Project Management for Construction and Development*. 5th ed. Chichester, West Sussex Wiley-Blackwell.

COLES, D., BAILEY, G. and CALVERT, R.E. (2012) *Introduction to Building Management*. London: Routledge.

COOKE, B. and WILLIAMS, P. (2009) *Construction Planning, Programming and Control*. Chichester, West Sussex: Wiley-Blackwell.

DAINTY, A. and LOOSEMORE, M. (2012) *Human Resource Management in Construction: Critical Perspectives*. 2nd ed. London: Routledge.

FORSTER, G. (1986) *Building Organisations, and Procedure*. Harlow: Longman Scientific & Technical.

HARRIS, F., MCCAFFER, R. and EDUM-FOTWE, F. (2013). *Modern Construction Management*. Chichester, West Sussex: Wiley-Blackwell.

HUGHES, P., PHILLIP, W. and FERRETT, E. *Introduction to Health & Safety in Construction: for the NEBOSH National Certificate in Construction Health & Safety*. 5th ed. Abingdon: Routledge.

### Websites

[www.ciob.org](http://www.ciob.org)

Chartered Institute of Building

[www.pmi.org](http://www.pmi.org)

Project Management Institute

[www.cipd.co.uk](http://www.cipd.co.uk)

Chartered Institute of Personnel and Development

[www.ice.org.uk](http://www.ice.org.uk)

Institutions of Civil Engineers

## **Links**

This unit links to the following related units:

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 13: Tender & Procurement*

*Unit 14: Building Information Modelling*

*Unit 23: Contracts & Management*

*Unit 24: Project Management*

*Unit 45: Maintenance & Operations*



## Unit 22: Group Project (Pearson-set)

<b>Unit code</b>	<b>D/615/1408</b>
<b>Unit type</b>	<b>Core</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>30</b>

### Introduction

While working in a team is an important skill in construction projects, collaboration goes beyond just teamwork. The success of a project relies not only on the ability of each person in a team to do their work, but on each individual's awareness of how their work relates to the work of others, how to ensure that information is shared effectively and that roles and responsibilities are clear.

Through this collaborative project-based unit, students will explore how to define roles within a collaborative team, recognising the skills (and 'skills gaps') of each member of the group. Together students will work to develop a construction project; based on their research and analysis, in response to the Pearson-set 'theme'.

Content in this unit will typically include role identification and allocation, collaborative structures, human resources management, project management, procurement, tender documentation, information/data sharing, meetings, Health & Safety, project costing and Building Information Modelling.

**\*Please refer to the accompanying Pearson-set Assignment Guide and the Theme Release document for further support and guidance on the delivery of the Pearson-set unit.**

## Learning Outcomes

By the end of this unit, students will be able to:

- 1 Assess individual and group skills in order to allocate roles within a collaborative team
- 2 Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling
- 3 Prepare tender documentation; undertaking work appropriate to a defined role within a team
- 4 Evaluate own work, and the work of others, in a collaborative team.

## Essential content

### LO1 **Assess individual and group skills in order to allocate roles within a collaborative team**

#### *Roles and responsibilities:*

Skills auditing

Belbin Team Inventory

Myers Briggs Personality Type Indicator.

#### *Human resources management:*

Core job dimensions (skill variety, task identity, task significance, autonomy, feedback)

Job design (job rotation, job enlargement, etc.).

### LO2 **Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling**

#### *Project planning:*

Setting goals

Defining 'deliverables'

Task definition

Identifying risks/risk management

Communications planning.

#### *Resource management:*

Human resources

Physical resources

Supply chain

Waste management.

#### *Project scheduling:*

Scheduling tools

Milestones

Blocks.

**LO3 Prepare tender documentation; undertaking work appropriate to a defined role within a team**

*Tender documentation:*

Construction drawings

Specifications

Schedules of work

Cost plan

Health & safety legislation

Building Information Modelling.

**LO4 Evaluate own work, and the work of others, in a collaborative team**

*Reflective practice:*

Schön's 'The Reflective Practitioner'

Gibbs' 'Reflective Cycle'

Reflection vs Description.

*Reflection in practice:*

Project lifecycle

Post implementation review.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Assess individual and group skills in order to allocate roles within a collaborative team		<b>D1</b> Justify the allocation of roles and responsibilities within a team, recognising individual skills and ambitions vs project requirements
<b>P1</b> Evaluate own skills and the skills of others through skills auditing and review <b>P2</b> Develop role descriptions and responsibilities within a team	<b>M1</b> Discuss the allocation of roles within a collaborative team to meet overall project needs	
<b>LO2</b> Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling		<b>LO2 and LO3</b> <b>D2</b> Critically evaluate the relationships between project planning and tender documentation, highlighting ways in which tender information responds to project planning
<b>P3</b> Develop a project plan to ensure successful achievement of completed project <b>P4</b> Illustrate resource planning (both physical and human) as well as time planning	<b>M2</b> Interpret events and activities in a project plan in order to indicate milestones, and risks	
<b>LO3</b> Prepare tender documentation; undertaking work appropriate to a defined role within a team		
<b>P5</b> Develop construction drawings and specifications <b>P6</b> Prepare a cost plan <b>P7</b> Produce a pre-construction Health & Safety method statement	<b>M3</b> Evaluate the ways in which Building Information Modelling can provide greater efficiency in collaborative preparation of tender documentation	
<b>LO4</b> Evaluate own work, and the work of others, in a collaborative team		<b>D3</b> Critically evaluate the success of a project by considering individual and group working practices in relation to assigned roles and personality profiles
<b>P8</b> Undertake a continual review of their own work, recording this throughout the project <b>P9</b> Evaluate their own working practices in relation to that of other members of the team, identifying areas of good practice	<b>M4</b> Evaluate their own personality profile in relation to your working practices	

## Recommended resources

### Textbooks

- BALDWIN, A. (2014) *Handbook for Construction Planning and Scheduling*, London: Wiley-Blackwell.
- BELBIN, M. (2010) *Team Roles at Work*. London: Taylor & Francis.
- BENNETT, J. and PEACE, S. (2006) *Partnering in Construction: A Code of Practice for Strategic Collaborative Working*. Abingdon: Butterworth-Heinemann.
- BOUCLAGHEM, D. (2011) *Collaborative Working in Construction*. London: Spon Press.
- CIOB (2010) *Guide to Good Practice in the Management of Time in Complex Projects*. 3rd ed. Chichester, West Sussex: John Wiley & Sons.
- DAINTY, A. and LOOSEMORE, M. (ed.) (2012) *Human Resource Management in Construction: Critical Perspectives*. Abingdon: Routledge.
- KELLY, J. and MALE, S. (1992) *Value Management in Design and Construction: The Economic Management of Project*. London: Taylor & Francis.
- MYERS, S. and CHILDS, R. (2016) *Understanding Team Roles*. London: Nielson Book Services Limited.
- POTTS, K. and ANKRAH, N. (2014) *Construction Cost Management: Learning from Case Studies*. London: Routledge.
- WYATT, D. (2007) *Construction Specifications: Principles and Applications*. New York: Delmar.

### Links

This unit links to the following related units:

*Unit 1: Individual Project*

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 24: Project Management*

*Unit 38: Personal Professional Development*

## Unit 23: Contracts & Management

<b>Unit code</b>	<b>H/615/1409</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The successful management of a project relies upon ensuring that work is undertaken in accordance with the terms of the contract that exists between client and contractor. In construction, a contract is the legally binding agreement between the client (who wants a project built) and the main contractor (who is responsible for constructing the project). Time, quality and costs are covered by such contracts to ensure that a client receives a project that has been specified by their designer to a budget and at an agreed handover date for completion.

The overall aim of this unit is to provide students with a working knowledge of contracts, so they can manage a project team in accordance with the agreed terms and conditions of the contract. The principle person responsible for this is often the quantity surveyor and it is their responsibility to ensure compliance with the conditions of the contract.

On successful completion of this unit students will be in a position to run and administer a project using the contract terms and conditions that have been agreed between a client and the main contractor. In addition, students will have the fundamental knowledge and skills to progress on to a higher level of study.

## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Discuss the requirements for a contract in meeting stakeholders' interests
- 2 Determine the criteria for the selection of a contract
- 3 Analyse different types of contract and their application to the built environment
- 4 Select and prepare an appropriate form of contract for a specific project, specifying the terms and conditions.



## Essential Content

### LO1 Discuss the requirements for a contract in meeting stakeholders' interests

#### *Clients' requirements:*

Statement of need, scope of services, responsibility for the design, design undertaken by an external architect, design to be undertaken by the contractor, liability for the design, professional indemnity for the design, performance bond, parent company guarantee, level of risk, the use of Building Information Modelling, strategic brief, required performance specification, procurement route, liability for overruns and delays, liability for cost overspends, level of quality required for the project, constraints on project duration, managing budgets and financial constraints to avoid overspends.

#### *Public body requirements:*

Level 2 Building Information Modelling, value for money (e.g. the Public Contracts Regulations 2015 or a local international agreement), local council purchasing strategy, pre-qualification questionnaires, compliance with equality legislation, Health & Safety and accident rates for main contractors, environmental management considerations, fair work practices, price benchmarking and cost targeting, engaged serial supply chain, efficiency and elimination of waste (e.g. a Buy Local scheme), Government International trade agreement, Private Finance Initiative 2 (PF2) and Public Private Partnerships (PPP).

### LO2 Determine the criteria for the selection of a contract

#### *Selection factors:*

Time in terms of a quick start and shorter completion date; cost in terms of the financial size of the undertaking; quality; the level of risk to be apportioned across all stakeholders; client and main contractor balance of risk; fixed price or variable price; will the contractor be undertaking the design; warranties and guarantees for workmanship and materials specification; basis of contract sum and payment options (e.g. phased, monthly); employers control over sub-contractors, nominated or named; lump sum or re-measured costs against a schedule of rates.

#### *Type of work to be undertaken:*

Maintenance or capital works, size, value and complexity of the project to be undertaken; knowledge and expertise of the employer or client; location, within UK or internationally, European location.

### LO3 **Analyse different types of contract and their application to the built environment**

#### *The Joints Contracts Tribunal Suite of Contracts:*

Traditional: JCT Standard Building Contract 2011 (the 'with Quantities' and 'without Quantities' versions), JCT Intermediate Building Contract 2011, JCT Minor Works Building Contract 2011

Traditional (re-measured): JCT Standard Building Contract 2011 (the 'with Approximate Quantities' version), JCT Measured Term Contract 2011

Design and Build: JCT Design and Build Contract 2011, JCT Major Project Construction Contract 2011

Construction Management: JCT Construction Management Appointment 2011, JCT Management Building Contract 2011

Partnering: JCT-Constructing Excellence Contract 2011, PPC2000 (2013 edition).

#### *The New Engineering Contract suite:*

New Engineering Contract (NEC3) and Engineering Construction Contract (ECC) and options A to F.

#### *International Federation of Consulting Engineers Contract Suite (FIDIC):*

Conditions of Contract for Works of Civil Engineering Construction: The Red Book (1987)

Conditions of Contract for Electrical and Mechanical Works, including Erection on Site: The Yellow Book (1987)

Conditions of Contract for Design-Build and Turnkey: The Orange Book (1995).

#### *Other types of contract:*

ICC Minor Works Version 2011, GC/Works series.

#### **LO4 Select and prepare an appropriate form of contract for a specific project, specifying the terms and conditions**

##### *Contract documents:*

Distinction between contract and non-contract documents; articles of agreement; conditions of and appendices to the different forms of contract; forms of contract used (construction and civil engineering projects); understand construction contracts in terms of supply chain management; supply chain management, nominated, named and other sub-contractors; suppliers, nominated and named sub-contractors; contract conditions; tendering arrangements; information requirements; main contract implications; forms and agreement; other sub-contractors; contract conditions; domestic; directly employed; tendering criteria.

##### *Quality:*

Materials; goods; standards of workmanship; specification; statutory obligations; methods of working; testing; defects and removal of defective work; quality assurance; other clauses of the contract, certificate of making good defects.

##### *Specific conditions:*

Articles of agreement; payment terms; variations; insurances; contractors' main responsibilities; testing and defects; architects/engineer instructions; risks.

##### *Time:*

Limitation of liability; possession; extensions of time; extensions and delays to contract period.

##### *Costs:*

Loss and expense; performance damages; performance bonds; retention; bonus for early completion; termination; price adjustments.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Discuss the requirements for a contract in meeting stakeholders' interests		<b>D1</b> Critically evaluate the contractual requirements for a public body in compliance with legislation
<b>P1</b> Explore the contractual requirements of a project for a private client  <b>P2</b> Explain the contractual requirements for a public body for an infrastructure project	<b>M1</b> Contrast the contractual requirements of a public and a private stakeholder for a major project	
<b>LO2</b> Determine the criteria for the selection of a contract		<b>D2</b> Evaluate a project in terms of risk for all stakeholders
<b>P3</b> Assess how time, cost and quality affect the selection of a contract  <b>P4</b> Evaluate the ways in which time and quality affect the cost of a project	<b>M2</b> Analyse a project in terms of the selection criteria for a contract that satisfies the requirements of a client	

Pass	Merit	Distinction
<b>L03</b> Analyse different types of contract and their application to the built environment		<b>L03 and L04</b> <b>D3</b> Justify the selection of a contract in meeting the strategic values of a client
<b>P5</b> Analyse the factors that influence the selection of a contract used to control and manage a project	<b>M3</b> Compare forms of standard contracts in terms of meeting a balanced risk	
<b>L04</b> Select and prepare an appropriate form of contract for a specific project, specifying the terms and conditions.		
<b>P6</b> Revise a standard contract in meeting the requirements of a client  <b>P7</b> Present the rationale for defining selected terms and conditions in the preparation of a contract	<b>M4</b> Compare the terms and conditions of similar contracts in meeting clients' requirements  <b>M5</b> Discuss how collaboration between contractors and sub-contractors influence contractual arrangements	

## Recommended resources

### Textbooks

CHAPPELL, D. (2015) *Construction Contracts Questions and Answers*. 3rd ed. London: Routledge.

CHAPPELL, D. (2012) *Understanding JCT Standard Building Contracts*. London: Routledge.

GODWIN, W. (2013) *International Construction Contracts: A Handbook*. Oxford: Wiley.

HUGHES, W., CHAMPION, R. and MURDOCH, J. (2015) *Construction Contracts Law and Management*. 5th ed. London: Routledge.

HUGHES, W.B. (2015) *Construction Contracts*. London: Routledge.

### Links

This unit links to the following related units:

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 13: Tender & Procurement*

*Unit 24: Project Management*

# Unit 24: Project Management

<b>Unit code</b>	<b>Y/615/1410</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

Management is key feature of a project from conception, through design and construction stages, into end-user and end-of-life cycles. Throughout this process, a project manager is called upon to manage stakeholders, facilitate communication and information sharing, and support different groups to ensure they are working to schedule, budget and contract.

Project managers will need to have sound knowledge, skills and competencies to manage all aspects of a complex construction project. This role may be fulfilled by a client representative or an external appointment.

The aim of this unit is to explore theories and practices relating to project management, the project manager role, and managing stakeholders throughout the project process.

Topics covered in this unit include: project management as a discipline and suitability for a range of construction industry activities; project stakeholder types and their management; project manager roles and responsibilities; project management plans.

On completion of this unit students will be able to apply the theories and practices of project management to real-world scenarios, and in doing so they will develop transferrable skills as well as equip themselves with industry-standard tools to work as an effective member of a project management team.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Compare project management theories, practices and standards; and their appropriateness for different types of project
- 2 Discuss the roles of the major stakeholders in a construction project and how their needs are managed by the project management team
- 3 Specify the attributes and competencies of a project manager in leading complex construction works
- 4 Develop a project strategy plan that defines the key policies, procedures and priorities for a complex construction project.



## Essential Content

### LO1 **Compare project management theories, practices and standards; and their appropriateness for different types of project**

#### *Project management:*

Definition of a project and project management

History of construction management and project management.

#### *Professional recognition and standards:*

Professional Bodies representing construction project managers

International project management standards

Techniques and guides, including PRINCE2 (Projects in Controlled Environments) and Project Management Body of Knowledge (PMBOK Guide).

### LO2 **Discuss the roles of the major stakeholders in a construction project and how their needs are managed by the project management team**

#### *Project stakeholders:*

Stakeholder definitions, types, key differences and relationships with the project

Stakeholders' power, interest, client influences, funding institutions, shareholders. Local authority, professionals, consultants, public interests, end user, owner, conflict of interest

Stakeholder collaboration and communication.

#### *Stakeholder governance and management*

### LO3 **Specify the attributes and competencies of a project manager leading complex construction works**

#### *Role of the project manager:*

Definition and role evolution

Responsibilities

Managing project teams.

#### *Project manager attributes, competencies and managerial skills*

**LO4 Develop a project strategy plan that defines the key policies, procedures and priorities for a complex construction project**

*Project management processes:*

Establishing stakeholder commitment

Defining scope

Setting aims and objectives

Project Execution Plan

Resource management

Communications

Evaluation.

*Project management techniques:*

Risk management

Key performance indicators (KPIs)

Value management

Sustainable construction techniques

Lean construction

Building Information Modelling (BIM).

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Compare project management theories, practices and standards; and their appropriateness for different types of project</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Analyse the theories that underpin project management for different types of complex construction projects</p>
<p><b>P1</b> Discuss the types of projects and project management in the context of construction activities.</p> <p><b>P2</b> Discuss the need for professional recognition and standards for project management</p>	<p><b>M1</b> Explore the development of project management as a discipline within the construction industry</p>	
<p><b>LO2</b> Discuss the roles of the major stakeholders in a construction project and how their needs are managed by the project management team</p>		
<p><b>P3</b> Review key stakeholder relationships and their influence on a complex construction project</p> <p><b>P4</b> Assess the importance of stakeholder communications and collaboration to achieve project success</p>	<p><b>M2</b> Evaluate stakeholder decision-making processes in complex construction projects</p>	

Pass	Merit	Distinction
<p><b>LO3</b> Specify the attributes and competencies of a project manager in leading complex construction works</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Present a Project Execution Plan that includes the scope, objectives, human and resource planning, and key priorities for a complex project</p>
<p><b>P5</b> Discuss the role and key responsibilities of a construction project manager</p> <p><b>P6</b> Assess the attributes, competencies and managerial skills of a construction project manager</p>	<p><b>M3</b> Compare the duties and qualities of a project manager for different types of complex construction projects</p>	
<p><b>LO4</b> Develop a project strategy plan that defines the key policies, procedures and priorities for a complex construction project</p>		
<p><b>P7</b> Examine the key project management processes and social responsibilities in a complex construction project</p> <p><b>P8</b> Prepare a project strategy plan, noting how sustainability will be managed</p>	<p><b>M4</b> Critically evaluate the adoption of Building Information Modelling in complex construction projects</p>	

## Recommended resources

### Textbooks

Chartered Institute of Building (2014) *Code of Practice for Project Management for Construction and Development*. 5th ed. Chichester, West Sussex: Wiley-Blackwell.

FEWINGS, P. (2013) *Construction Project Management: An Integrated Approach*. 2nd ed. London: Routledge.

Office of Government Commerce (2009) *Managing Successful Projects with Prince2*. London: The Stationery Office.

Project Management Institute (2013) *A Guide to the Project Management Body of Knowledge*. 5th ed. Project Management Institute.

SEARS, S.K., SEARS, G.A., CLOUGH, R.H., ROUNDS, J.L. and SEGNER, R.O. (2015) *Construction Project Management: A Practical Guide to Field Construction Management*. 6th ed. Oxford: John Wiley & Sons Inc.

### Websites

<a href="http://www.apm.org.uk">www.apm.org.uk</a>	Association for Project Management (General Reference)
<a href="http://www.prince2.com">www.prince2.com</a>	Prince2 (General Reference)
<a href="http://www.pmi.org">www.pmi.org</a>	Project Management Institute (General Reference)

### Links

This unit links to the following related units:

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 25: Management for Complex Building Projects*

*Unit 34: Advanced Quantities for Complex Building Projects*

*Unit 44: Advanced Surveying & Measurement*

# Unit 25: Management for Complex Building Projects

<b>Unit code</b>	<b>D/615/1411</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

This unit is designed to focus on factors that are involved in the relationship between the complexity of large construction projects and the management strategies required to plan, organise and co-ordinate such projects.

This unit also supports students to analyse total Health & Safety management in the light of new and existing legislation and construction contracts, and the impact it has on issues surrounding construction management.

Topics included in this unit are: management strategies, contract planning, pre-project phase, planning and design, contract selection phase, project operations, project closeout and termination phase, management team, organisational systems, cash flow/funding.

Students will be able to gain an insight into the workings of all the stakeholders who are linked together through the process of managing complex buildings, including the identification of the various project delivery systems which form the basis of contractual relationships.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Specify the management strategies that may apply at the commencement of construction projects
- 2 Review the main functions of construction management and team management in relation to complex buildings
- 3 Analyse the professional relationships involved in managing, planning and co-ordinating complex projects
- 4 Discuss contract planning techniques for complex building projects, utilising systems, technologies and supporting instruments for planning/management.

## Essential content

### LO1 **Specify the management strategies that may apply at the commencement of construction projects**

#### *Strategies:*

Bench marking, re-engineering, partnering and alliancing, risk management

Total Safety Management, Total Quality Management, Value Management

Lean construction, constructability

Techniques, innovative management strategies

Construction planning

Project planning

Case studies.

### LO2 **Review the main functions of construction management and team management in relation to complex buildings**

#### *Main functions:*

Scope, cost, time, human resources, effective communication, quality contract risk, project integration, CDM regulations, building regulations, build ability.

#### *Construction team:*

Client, architect, project manager, site manager, site engineers, quantity surveyor

Sub-contractor manager, plant manager.

### LO3 **Analyse the professional relationships involved in managing, planning and co-ordinating complex projects**

*Pre-contract planning, tender performance, pre-contract arrangements, organisational structures, site planning, site layouts, planning activities*

*Sub-contractors, suppliers, schedules, plant and equipment schedule, master programme, budget/valuations, budgetary control procedures, cash forecast, cash flow, sales budgets*



**LO4 Discuss contract planning techniques for complex building projects, utilising systems, technologies and supporting instruments for planning/management**

*Organisation systems:*

Tree diagrams

Roles and responsibilities

Master programme

Contract budget programme

Programme sequence

Network programme

Network diagram

Line of balance.

*Complex building projects:*

Civil engineering and construction projects

Design and build

Public, private contracts

Self-funded projects

Traditional management contracting

Health & safety considerations

Demolition

Additional costing

Building control constraints.

*Cost envelope principles:*

Value/time relationships

Time cost techniques

Site works

BIM

Procurement.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Specify the management strategies that may apply at the commencement of construction projects</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Justify a commencement and management strategy for a complex building, with regard to construction management team roles</p>
<p><b>P1</b> Explore the strategies that may be applied at the commencement of a construction project</p> <p><b>P2</b> Discuss how project management techniques and strategies impact on the effectiveness of construction planning</p>	<p><b>M1</b> Analyse how construction strategies and planning techniques have advanced modern construction management techniques</p>	
<p><b>LO2</b> Review the main functions of construction management and the management team in relation to complex buildings</p>		
<p><b>P3</b> Evaluate the main roles of the construction team within the management process</p> <p><b>P4</b> Demonstrate how parties collaborate to support and achieve management planning of complex building projects</p>	<p><b>M2</b> Illustrate the main roles in construction and how collaborative stakeholders function together as a team</p>	

Pass	Merit	Distinction
<p><b>LO3</b> Analyse the professional relationships involved in managing, planning and co-ordinating complex projects</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Critically evaluate a contract programme with regard to the way that stakeholders may contribute to the process through different stages</p>
<p><b>P5</b> Produce an organisational chart/programme, mapping the relationships of the parties within the construction management team</p> <p><b>P6</b> Evaluate the importance of sub-contractors within the construction industry</p>	<p><b>M3</b> Analyse how information flows between parties in a project, including the significance of the tendering/bidding process, pre-contract arrangements, and budgets</p>	
<p><b>LO4</b> Discuss contract planning techniques for complex building projects, utilising systems, technologies and supporting instruments for planning/management</p>		
<p><b>P7</b> Illustrate the contract programme for a given construction project; highlighting costing, budget, profit</p> <p><b>P8</b> Discuss how health &amp; safety and BIM has changed the construction industry, focusing on complex buildings</p>	<p><b>M4</b> Demonstrate the relationship between planning and the support mechanisms which underpin the development and management of a complex building</p>	

## Recommended resources

### Textbooks

CHUDLEY, R., GREENO, R. and HURST, M. (2011) *Construction Technology*. 5th ed. London: Prentice Hall.

COOKE, B. and WILLIAMS, P. (2009) *Construction Planning Programming and Control*. 3rd ed. Chichester, West Sussex: Wiley-Blackwell.

LESTER, A. (2007) *Project Management Planning and Control*. 5th ed. Oxford: Butterworth-Heinemann.

MURRAY, M. and LANGFORD, D. (2004) *Architects Handbook of Construction Project Management*. London: RIBA Publishing.

WARDE, P.A. (1979) *Organisation and Procedures in the Construction Industry*. Plymouth: McDonald Evans.

### Websites

[www.ciob.org.uk](http://www.ciob.org.uk)

Chartered Institute of Buildings  
(General Reference)

[www.rics.org](http://www.rics.org)

Royal Institute of Chartered Surveyors  
(General Reference)

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 13: Tender & Procurement*

*Unit 14: Building Information Modelling*

*Unit 24: Project Management*

*Unit 32: Building Management Systems*

*Unit 34: Advanced Quantities for Complex Building Projects*

*Unit 36: Advanced Building Information Modelling*

*Unit 45: Maintenance & Operations*

## Unit 26: Advanced Construction Drawing & Detailing

<b>Unit code</b>	<b>H/615/1412</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The information required to construct buildings and infrastructure is at the heart of the construction process. As structures become more complex, the types of information required become equally complex. The ability to produce, manage and understand construction information continues to be a key skill at all levels of the industry.

The aim of this unit is to provide students with an in-depth consideration of the way that construction information is created, managed, and shared throughout the lifecycle of a built asset. In addition to understanding the types of information required for complex projects, students will explore the development and use of standards to ensure consistency and interoperability of data captured and shared, both in a geometric and non-geometric fashion.

Through this unit students will engage in the ways construction drawing and detailing have evolved and will be able to gain knowledge and skills in documenting projects using modern methods and technologies.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Assemble complex construction information packages to meet diverse project needs
- 2 Integrate design and construction information data from multiple sources
- 3 Evaluate the relationship between CAD and BIM data in the production and management of construction information
- 4 Prepare construction information packages for a given complex building project.

## Essential content

### LO1 Assemble complex construction information packages to meet diverse project needs

#### *Standards:*

Office standards (templates, formats, etc.)

Industry standards (formats, information packages, etc.)

Classification systems (Uniclass, Omniclass, etc.)

Common Arrangement of Works (CAWS)

Best practice drawing and detailing

File formats and use of complex technology to create standards, both organisational and project-based.

#### *General arrangement drawings:*

Splitting complex plans, match lines

Room/space delineation

Annotation

Cross-referencing.

#### *Detail drawings:*

Identifying detail needs

Detail annotation

Level of Definition (Level of Detail)

Linking specification data with drawing data

The definition of graphical and non-graphical data in the context of BIM.

## LO2 **Integrate design and construction information data from multiple sources**

### *Drawings:*

Creating drawings from traditional systems, such as Computer Aided Design (CAD) software and BIM authoring software

The differences between traditional 2D drafting and 3D modelling

The use of 3D modelling as a source to create 2D drawings

Linking 2D drawings and data into 3D modelling tools.

### *Specifications:*

Specification writing

Linking specification data within a BIM authoring platform. Schedules or data sheets:

Schedules from traditional means

Creating schedules from BIM authoring platform

Creating co-ordination reports from BIM Co-ordination platform.

### *Detailing:*

Creating details from 2D CAD software

Creating detail drawings from 3D BIM authoring platform

Information management within BIM authoring platform

Details which link to 3D data.

## LO3 **Evaluate the relationship between CAD and BIM data in the production and management of construction information**

### *Design information:*

CAD design drawings and the use of modelling tools to inform building shape and form

BIM authoring solutions which link to design data

Advanced digital tools that automate shape and form

Co-ordinating CAD and BIM data to review detailed design solutions prior to construction

Co-ordinating discipline-specific design information.



*Construction information:*

Linking CAD data to BIM authoring software

Using BIM authoring software to manage and produce information

Using open file formats (e.g. Open BIM) to ensure all data can be transferred across differing platforms

Understand the term 'project information model (PIM)'.

*Handover and post-occupancy information:*

Transfer the information from a project information model to the asset data

Linking CAD data to a facilities management tool

Archiving data at handover

Updating data through the life of a project

Updating drawings or model information through the life of a project

Maintenance and repair data.

**LO4 Prepare construction information packages for a given complex building project**

*Design stages and data drops:*

Allocating tasks to a particular supplier

Defining information or data deliverables over the lifecycle of a given project

Defining what type of information should be shared and how this is stored and managed at all stages of a project.

*Construction information packages:*

Design responsibility matrix

Reviewing CAD and BIM information at all times through the life of a project

Defining the data deliverable for a given project

Reviewing co-ordination issues during the construction stages

Transferring ownership of BIM data to differing sources.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Assemble complex construction information packages to meet diverse project needs		<b>LO1 and LO2</b>  <b>D1</b> Create a consistent set of standards for both a complex construction project and an organisation, recognising ways to retain consistency and clarity within the information shared and created to avoid error and duplication
<b>P1</b> Discuss the importance of defining standards to create and manage construction drawings  <b>P2</b> Evaluate the importance of consistent and accurate information in regard to creating construction drawings for a complex project	<b>M1</b> Analyse how a consistent set of standards can drive greater efficiencies throughout a project  <b>M2</b> Utilise both BIM and CAD methodology to ensure construction information packages are correct and clear for a complex project	
<b>LO2</b> Integrate design and construction information data from multiple sources		
<b>P3</b> Assess ways in which construction information can be created in both a traditional and a digitally integrated fashion	<b>M3</b> Analyse the difference between CAD and BIM systems in the creation of design and construction information for a given project	

Pass	Merit	Distinction
<p><b>LO3</b> Evaluate the relationship between CAD and BIM data in the production and management of construction information</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Critically evaluate ways in which BIM data can support more accurate information on a complex project</p>
<p><b>P4</b> Evaluate the advantages of using a BIM-based system to create complex construction information</p> <p><b>P5</b> Discuss ways in which BIM authoring tools can consistently create accurate drawings and details for a complex project</p>	<p><b>M4</b> Review the ways in which BIM data can be accurately created and maintained throughout all stages of a complex project</p>	
<p><b>LO4</b> Prepare construction information packages for a given complex building project</p>		
<p><b>P6</b> Create a set of construction documents for a complex building project using defined standards</p> <p><b>P7</b> Demonstrate how information created in a non-graphical way can be utilised within a BIM authoring platform</p> <p><b>P8</b> Discuss how drawing packages can be organised within the context of a BIM authoring platform</p>	<p><b>M5</b> Analyse how construction information packages can be created accurately in line with detailed requirements outlined by a given client for a complex construction project</p>	

## Recommended resources

### Textbooks

CROTTY, R. (2012) *The Impact of Building Information Modelling: Transforming Construction*. London: Spon Press.

EASTMEN, C., TEICHOLZ, P., SACKS, R. and LISTON, K. (2011) *BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors*. 2nd ed. Oxford: John Wiley & Sons Inc.

FAIRHEAD, R. (2013) *Information Exchanges: RIBA Plan of Work 2013 Guide*. London: RIBA Publishing.

SHEPHERD, D. (2015) *BIM Management Handbook*. London: RIBA Publishing.

### Websites

<a href="http://www.theb1m.com">www.theb1m.com</a>	The B1M (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group 'COBie UK 2012' (General Reference)
<a href="http://www.thenbs.com">www.thenbs.com</a>	NBS 'BIM (Building Information Modelling)' (General Reference)

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 14: Building Information Modelling*

*Unit 27: Construction Technology for Complex Building Projects*

*Unit 36: Advanced Building Information Modelling*

# Unit 27: Construction Technology for Complex Building Projects

<b>Unit code</b>	<b>K/615/1413</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

This unit focuses on the erection of buildings with complex requirements by the use of modern systems and methods of construction. The principles of buildability in terms of Health & Safety, efficiency, economy, sustainability and quality are analysed. The importance of developing a sustainable construction strategy is emphasised and students will explore the techniques and procedures involved in the safe and sustainable demolition of buildings. The importance of clear technical communication is also examined during and after the build process.

This unit is designed to provide students with a thorough understanding regarding the technology involved in complex buildings. Students will discover how scientific solutions are applied to complex building projects through technology, the choice of materials, buildability and construction methods. Particular emphasis will be on the consideration of sustainability and health & safety in the building of complex structures.

On successful completion of this unit students will have related suitable strategies, processes and means of construction to meet prevailing conditions. The student will justify selected materials and construction methods used in complex buildings against set criteria, and choose systems to facilitate alternative uses of buildings. A specification/design reasonably capable of meeting the requirements of a building throughout its life will be produced by each student.

## Learning Outcomes

By the end of this unit, students will be able to:

- 1 Evaluate strategies, processes and construction technology for the substructure and superstructure requirements of complex buildings
- 2 Justify materials, technology and processes used to construct substructures and superstructures for complex buildings, against time, cost and quality
- 3 Select substructures, superstructures, building services systems and internal partition walling, flooring and ceilings to provide flexibility of conditioned spaces
- 4 Propose solutions that meet the requirements of safe demolition and disposal of materials and components with regard to buildability, performance and Health & Safety.

## Essential Content

### LO1 Evaluate strategies, processes and construction technology for the substructure and superstructure requirements of complex buildings

*Types of construction:*

High rise buildings e.g. flats, hotels, mixed use and other buildings, such as hospitals and prisons; commercial buildings e.g. offices, shopping centres, airport terminal and football stadiums; industrial buildings e.g. laboratories, factories, production halls and large distribution centres; underground buildings and as defined by the International Building Code (IBC).

*Preliminaries, enabling work, contamination, water exclusion, infrastructure; ground movement, differential settlement, heave/shrinkage, arccology; substructure, piling, vibro compaction, mats, pier, compensated foundations; basements, hydrostatic pressure, waterproofing, geology, radon, methane; superstructure, skeletal, core, cross wall, tunnel and jump forming, prefabricated construction, curtain walling, rain screen cladding, solar gain; top-down building.*

### LO2 Justify materials, technology and processes used to construct substructures and superstructures for complex buildings, against time, cost and quality

*Movement, thermal, wind, vortices modelling, air tightness, weather resistance; access, egress, stairs, lifts, fire strategy, refuge room, disproportionate collapse; building management systems, Building Information Modelling (BIM); facilities management and maintenance; sustainable urban drainage systems (SUDS); plant, cranes, pumps, hoists; legal requirements, buildability, Health & Safety.*

### LO3 Select substructures, superstructures, building services systems and internal partition walling, flooring and ceilings to provide flexibility of conditioned spaces

*Beams, long span, cellular, lattice; permanent steel formwork, bracing and trusses; primary service supplies, metering and access, secondary and back-up power; hot and cold water, gas, electricity, drainage, heating, ventilation, air conditioning, telephone and high speed digital communications, waste removal, cleaning; sprinklers, emergency lighting, pressurisation, smoke handling, firefighting lifts; raised access flooring, suspended ceilings, service walls and ducts, demountable walls.*

**LO4 Propose solutions that meet the requirements of safe demolition and disposal of materials and components with due regard to buildability, performance and Health & Safety**

*Sustainability, re-use or reclamation of standard components and assemblies.  
Specification of recyclable materials*

*Consideration of access for safe demolition, simplicity of deconstruction*

*Legal constraints and regulatory requirements*

*Health & safety considerations*

*Building Information Modelling in deconstruction*

*Construction information:*

Drawings, details

Specifications

Schedules

CAD

BIM.



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Evaluate strategies, processes and construction technology for the substructure and superstructure requirements of complex buildings		
<b>P1</b> Discuss construction technology issues from given complex building projects  <b>P2</b> Evaluate construction strategies that address technical issues	<b>M1</b> Assess how technical strategies can mitigate issues in construction	<b>D1</b> Compare alternative construction technology strategies for a given complex building
<b>LO2</b> Justify materials, technology and processes used to construct substructures and superstructures for complex buildings, against time, cost and quality		
<b>P3</b> Propose materials and construction methods for a given complex building project  <b>P4</b> Justify materials and construction methods** decisions as they impact on cost, time and quality	<b>M2</b> Compare different approaches to material and construction method to determine their suitability for a given building project	<b>D2</b> Critically evaluate against time, cost and quality, the materials, technology and processes required to construct a given complex building

Pass	Merit	Distinction
<p><b>L03</b> Select substructures, superstructures, building services systems and internal partition walling, flooring and ceilings to provide flexibility of conditioned spaces</p>		
<p><b>P5</b> Compare different types of building components in selecting for use in providing flexibility of conditioned space</p> <p><b>P6</b> Examine suitable systems to enable alternative building uses</p>	<p><b>M3</b> Discuss how the use of Building Information Modelling facilitates the selection of suitable construction materials and systems</p>	<p><b>L03 and L04</b></p> <p><b>D3</b> Justify the need for re-use, reclamation or recycling at demolition to achieve greater sustainability in a building construction strategy</p>
<p><b>L04</b> Propose solutions that meet the requirements of safe demolition and disposal of materials and components with regard to buildability, performance and Health &amp; Safety</p>		
<p><b>P7</b> Specify demolition systems to meet the buildability requirements of a proposed building</p> <p><b>P8</b> Prepare an outline design for an assigned building type with regard to safe demolition</p> <p><b>P9</b> Prepare documentation (drawings, specifications) for a proposed design solution, recognising safe demolition</p>	<p><b>M4</b> Discuss the benefits of Building Information Modelling in the production of construction information for complex buildings</p>	

## Recommended resources

### Textbooks

ADDIS, B. (2006) *Building with Reclaimed Components and Materials: A Design Handbook for Reuse and Recycling*. London: Taylor & Francis.

BROOKES, A. and GRECH, C. (1992) *Connections*. Oxford: Butterworth-Heinemann.

BROOKES, A. and GRECH, C. (1992) *The Building Envelope*. Oxford: Butterworth-Heinemann.

BRYAN, T. (2010) *Construction Technology Analysis and Choice*. Chichester, West Sussex: Wiley-Blackwell.

CHING, F.D.K. (2008) *Building Construction Illustrated*. Chichester: Wiley.

CIRIA (2004) *Design for Deconstruction: Principles of Design to Facilitate Reuse and Recycling Guide*. C607. London: CIRIA.

COOKE, R. (2007) *Building in the 21st Century*. Blackwell.

GORSE, S.E. (2010) *Barry's Advanced Construction of Buildings*. Chichester, West Sussex: Wiley-Blackwell.

GREENO, R.C. (2008) *Building Construction Handbook*. 7th ed. Oxford: Butterworth-Heinemann.

### Websites

<a href="http://www.ciat.org.uk">www.ciat.org.uk</a>	Chartered Institute of Architectural Technologists (General Reference)
<a href="http://www.cbuilde.com">www.cbuilde.com</a>	Chartered Association of Building Engineers (General Reference)
<a href="http://www.istructe.org">www.istructe.org</a>	Institution of Structural Engineers (General Reference)
<a href="http://www.bre.org.uk">www.bre.org.uk</a>	British Research Establishment (General Reference)
<a href="http://www.concretecentre.com">www.concretecentre.com</a>	The Concrete Centre (General Reference)

## **Links**

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 14: Building Information Modelling*

*Unit 18: Civil Engineering Technology*

*Unit 25: Management for Complex Building Projects*

*Unit 30: Advanced Structural Design*

*Unit 36: Advanced Building Information Modelling*

*Unit 47: Construction Data Management*

**NOTE: The Assessment Criteria of this unit have been changed. This unit descriptor is suitable for teaching and assessment after August 2020.**

**Students registered prior to August 2020 must be assessed using the unit descriptor found in Appendix 7 of this programme specification.**

## Unit 28: Further Mathematics for Construction

<b>Unit code</b>	<b>M/615/1414</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The understanding of more advanced mathematics is important within the civil engineering and building services engineering industries. Students must be introduced to additional topics that will be relevant to them as they progress to the next level of their studies; advancing their knowledge of mathematical theory gained in the Level 4 Unit 8: Mathematics for Construction.

The aim of this unit is to teach students to analyse and model civil engineering or building services engineering situations using mathematical techniques.

Among the topics included in this unit are: number theory, complex numbers, matrix theory, linear equations, numerical integration, numerical differentiation, and graphical representations of curves for estimation within an engineering context. Finally, students will expand their knowledge of calculus to discover how to model and solve problems using first and second order differential equations.

On successful completion of this unit students will be able to use applications of number theory in practical construction situations, solve systems of linear equations relevant to construction applications using matrix methods, approximate solutions of contextualised examples with graphical and numerical methods, and review models of construction systems using ordinary differential equations. As a result, they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Apply instances of number theory in practical construction situations
- 2 Solve systems of linear equations relevant to construction applications using matrix methods
- 3 Approximate solutions of contextualised examples with graphical and numerical methods
- 4 Review models of construction systems using ordinary differential equations.

## Essential Content

### LO1 **Apply instances of number theory in practical construction situations**

#### *Number theory:*

Bases of a number (Denary, Binary, Octal, Duodecimal, Hexadecimal) and converting between bases

Types of numbers (Natural, Integer, Rational, Real, Complex)

The modulus, argument and conjugate of complex numbers

Polar and exponential form of complex numbers

The use of de Moivre's Theorem in engineering

Complex number applications e.g. electric circuit analysis, information and energy control systems.

### LO2 **Solve systems of linear equations relevant to construction applications using matrix methods**

#### *Matrix methods:*

Introduction to matrices and matrix notation

The process for addition, subtraction and multiplication of matrices

Introducing the determinant of a matrix and calculating the determinant for a 2x2 matrix

Using the inverse of a square matrix to solve linear equations

Gaussian elimination to solve systems of linear equations (up to 3x3).

### LO3 **Approximate solutions of contextualised examples with graphical and numerical methods**

#### *Graphical and numerical methods:*

Standard curves of common functions, including quadratic, cubic, logarithm and exponential curve

Systematic curve sketching knowing the equation of the curve

Using sketches to approximate solutions of equations

Numerical analysis using the bisection method and the Newton-Raphson method

Numerical integration using mid-ordinate rule, the trapezium rule and Simpson's rule.

#### LO4 **Review models of construction systems using ordinary differential equations**

*Differential equations:*

Formation and solutions of first-order differential equations

Applications of first-order differential equations e.g. RC and RL electric circuits, Newton's laws of cooling, charge and discharge of electrical capacitors, and complex stresses and strains

Formation and solutions of second-order differential equations

Applications of second-order differential equations e.g. mass-spring-damper systems, information and energy control systems, heat transfer, automatic control systems and beam theory and RLC circuits

Introduction to Laplace transforms for solving linear ordinary differential equations

Applications involving Laplace transforms, such as electric circuit theory, load frequency control, harmonic vibrations of beams and engine governors.



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Apply instances of number theory in practical construction situations		<b>D1</b> Test the correctness of a trigonometric identity using de Moivre's Theorem
<p><b>P1</b> Apply addition and multiplication methods to numbers that are expressed in different base systems</p> <p><b>P2</b> Solve construction problems using complex number theory</p> <p><b>P3</b> Perform arithmetic operations using the polar and exponential form of complex numbers</p>	<b>M1</b> Deduce solutions of problems using de Moivre's Theorem	
<b>LO2</b> Solve systems of linear equations relevant to construction applications using matrix methods		<b>D2</b> Validate all analytical matrix solutions using appropriate computer software
<p><b>P4</b> Ascertain the determinant of a 3x3 matrix</p> <p><b>P5</b> Solve a system of three linear equations using Gaussian elimination</p>	<b>M2</b> Determine solutions to a set of linear equations using the inverse matrix method	

Pass	Merit	Distinction
<p><b>L03</b> Approximate solutions of contextualised examples with graphical and numerical methods</p>		<p><b>D3</b> Critique the use of numerical estimation methods, commenting on their applicability and the accuracy of the methods</p>
<p><b>P6</b> Estimate solutions of sketched functions using a graphical estimation method</p> <p><b>P7</b> Identify the roots of an equation using two different iterative techniques</p> <p><b>P8</b> Determine the numerical integral of construction functions using two different methods</p>	<p><b>M3</b> Evaluate construction problems to formulate mathematical models using numerical and graphical methods</p>	
<p><b>L04</b> Review models of construction systems using ordinary differential equations</p>		<p><b>D4</b> Evaluate first- and second-order differential equations when generating the solutions to construction problems</p>
<p><b>P9</b> Determine first-order differential equations using analytical methods</p> <p><b>P10</b> Determine second-order homogeneous and non-homogenous differential equations using analytical methods</p> <p><b>P11</b> Calculate solutions to linear ordinary differential equations using Laplace transforms</p>	<p><b>M4</b> Analyse how first-order differential equations are used to solve structural or environmental problems</p>	

## Recommended resources

### Textbooks

BIRD, J. (2014) *Higher Engineering Mathematics*. 7th ed. London: Routledge.

SINGH, K. (2011) *Engineering Mathematics Through Applications*.  
Basingstoke: Palgrave Macmillan.

STROUD, K.A. and BOOTH, D.J. (2013) *Engineering Mathematics*. 7th ed.  
Basingstoke: Palgrave Macmillan.

### Websites

[www.mathcentre.ac.uk](http://www.mathcentre.ac.uk)                      MathCentre  
(General Reference)

[www.mathtutor.ac.uk](http://www.mathtutor.ac.uk)                      MathTutor  
(General Reference)

### Links

This unit links to the following related units:

*Unit 3: Science & Materials*

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 11: Measurement & Estimating*

*Unit 17: Principles of Public Health Engineering*

*Unit 29: Geotechnics & Soil Mechanics*

*Unit 30: Advanced Structural Design*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 33: Advanced Electrical Design & Installation*

*Unit 34: Advanced Quantities for Complex Building Projects*

*Unit 42: Highway Engineering*

*Unit 44: Advanced Surveying & Measurement*

## Unit 29: Geotechnics & Soil Mechanics

<b>Unit code</b>	<b>T/615/1415</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

This unit explores the essential relationship between civil engineering and the Earth's crust, in the support of built structures and highways. The ability to understand, evaluate and develop solutions, related to soil and rock, is a key aspect of civil and structural engineering.

Topics included in this unit are: rock types, soil description and classification, methods and techniques used when undertaking site investigations and laboratory testing, determination of soil properties and the importance of these geotechnical procedures and resultant findings to civil engineers.

On successful completion of this unit students will be able to analyse and evaluate modern geotechnical methods and apply these skills and knowledge to the initial design of infrastructure.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Review rock types, their formation and uses within civil engineering
- 2 Explore and classify soils to current codes of practice
- 3 Analyse soil properties determined by geotechnical procedures
- 4 Produce a proposal to address identified geotechnical weaknesses and problems.

## **Essential Content**

### **LO1 Review rock types, their formation and uses within civil engineering**

*Rock type formation and classification*

*Rock type susceptibility to weathering and weathering processes*

*Discontinuous nature of rock mass, folding and faulting*

*The use of rock within civil engineering*

*The use of uncemented sediments within civil engineering*

### **LO2 Describe and classify soils to current codes of practice**

*Ground and site investigation*

*Soil sampling*

*Soil types*

*Soil description*

*Soil classifications*

*Soil particle size*

*Soil specific gravity*

*Soil plasticity index*

### **LO3 Analyse soil properties determined by geotechnical procedures**

*Shear strength*

*Compressibility*

*Moisture content*

*Soil density*

*Specific gravity*

*Liquid and plasticity indices*

*California bearing ratio*

**LO4 Produce a proposal to address identified geotechnical weaknesses and problems**

*Shear strength and embankment design*

*Compressibility and foundation design*

*Liquid and plasticity indices and foundation design*

California bearing ratio and highway design.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Evaluate rock types, their formation and uses within civil engineering		<b>D1</b> Critically analyse example that address problems caused by the discontinuous nature of rock mass when tunnelling and constructing bridges, using case studies as examples
<p><b>P1</b> Discuss rock type formation and classification, susceptibility to weathering and the weathering processes</p> <p><b>P2</b> Analyse the discontinuous nature of rock mass</p>	<p><b>M1</b> Evaluate the use of rock and uncemented sediments within civil engineering</p>	
<b>LO2</b> Explore and classify soils to current codes of practice		<b>D2</b> Assess the importance of site investigation, soil sampling and determination of soil properties for infrastructure projects
<p><b>P3</b> Explore methods and techniques used in ground and site investigation, soil sampling, soil descriptions and soil classifications to current codes of practice</p> <p><b>P4</b> Explore how soils are classified from soil particle size, soil types, specific gravity and plasticity indices to current codes of practice</p>	<p><b>M2</b> Evaluate methods and techniques used in ground and site investigation and soil sampling</p>	



Pass	Merit	Distinction
<b>L03</b> Analyse soil properties determined by geotechnical procedures		<b>L03 and L04</b> <b>D3</b> Integrate test data to inform the development of design proposals
<b>P5</b> Evaluate how soil properties are determined, including moisture content, density, specific gravity, shear strength compressibility, liquid and plasticity indices, California bearing ratio	<b>M3</b> Analyse results from soil properties testing	
<b>L04</b> Produce a proposal to address identified geotechnical weaknesses and problems		
<b>P6</b> Produce design proposals to address geotechnical problems related to embankments, bridge and road foundations for a given site	<b>M4</b> Justify the approach to a design proposal in meeting identified geotechnical weaknesses	

## Recommended resources

### Textbooks

CHUDLEY, R. and GREENO, R. (2012) *Advanced Construction Technology*. 5th ed. Harlow: Pearson.

CHUDLEY, R. and GREENO, R. (2014) *Building Construction Handbook*. 10th ed. Oxford: Butterworth-Heinemann.

MANLEY, S., CHARTERS, M., FRANCIS, C., TOPLISS, S. and DOYLE, M. (2008) *Construction*. Harlow: Pearson.

MCLEAN, A. and GRIBBLE, C. (1985) *Geology for Civil Engineers*. London: Routledge.

OSBOURN, D. and GREENO, R. (2007) *Introduction to Building*. 4th ed. Harlow: Pearson.

### Websites

<a href="http://www.ciob.org.uk">www.ciob.org.uk</a>	Chartered Institute of Building (General Reference)
<a href="http://www.geology.com">www.geology.com</a>	Geology.com – Geology News and Information (General Reference)
<a href="http://www.ice.org.uk">www.ice.org.uk</a>	Institution of Civil Engineers
<a href="http://www.thomastelford.com">www.thomastelford.com</a>	Thomas Telford (General Reference)

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 8: Mathematics for Construction*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 30: Advanced Structural Design*

*Unit 42: Highway Engineering*

*Unit 43: Hydraulics*

# Unit 30: Advanced Structural Design

<b>Unit code</b>	<b>A/615/1416</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

With the development of new materials and processes, along with technologies that allow us to design and model more complex structures, the demands on structural design become more complex. The ability to conceive of and accurately model complex buildings, bridges, roads and other types of structure, pushes both the aesthetic and technical envelope.

In managing the design and construction of modern structures, the civil or structural engineer must be able to carry out more complex calculations; dealing with dynamic conditions, while maintaining an awareness of the overall design intention.

Extending areas of study, from *Unit 20: Principles of Structural Design*, this unit will support students to extend their ability to design, test and quantify more complex structural conditions.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Explore deflection due to wind loadings, on fixed structures, and strategies to resist wind loading
- 2 Determine bending, shear and deflection for complex support conditions
- 3 Design complex columns and piled foundations based on calculation
- 4 Explore the design of tensile structures.

## Essential Content

### LO1 Explore deflection due to wind loadings, on fixed structures, and strategies to resist wind loading

#### *Wind loading:*

Calculating wind loading

Wind loading on tall buildings

Shear forces

Lateral load

Uplift load

Torsional load.

#### *Managing wind loading:*

Building form

Stiffening.

### LO2 Determine bending, shear and deflection for complex support conditions

#### *Bending:*

Supported timber beams

Steel cantilever beams

Reinforced concrete cantilevers

Steel three-pin frames.

#### *Shear:*

Supported timber beams

Steel three-pin frames.

#### *Deflection:*

Supported timber beams with point loads and uniformly distributed loading

Steel cantilever beams with point loads and uniformly distributed loading

Reinforced concrete cantilever beams with point loads and uniformly distributed loading.

*Structural connections:*

Beam-to-beam connections

Beam-to-column connections

Types of connection

Bolt fixings

Welded connections

Fin plates

Splices

Bracing connections.

**LO3 Design complex columns and piled foundations based on calculation**

*Axial loading:*

Carrying capacity of timber columns

Carrying capacity of reinforced concrete piled foundations

Carrying capacity of steel piled foundations.

*Eccentric loading:*

Buckling

Stress.

*Piled foundations:*

End bearing piles

Friction piles

Sheet piles

Micropiling

Helical piles.

*Structural design information:*

CAD drawings

Building Information Modelling

Calculations.

## LO4 Explore the design of tensile structures

### *Linear structures:*

Suspension bridges

Cable-stayed beams/trusses.

### *Three-dimensional structures:*

Tensegrity structures

Tensairity structures.

### *Surface-stressed structures:*

Pre-stressed membranes

Gridshell

Fabric structure.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Explore deflection due to wind loadings, on fixed structures, and strategies to resist wind loading		<b>D1</b> Calculate and size the type of lateral stiffening required to resist wind loading for a given structure
<b>P1</b> Calculate wind loads on fixed structures <b>P2</b> Discuss methods to resist or manage wind loading	<b>M1</b> Analyse the relationship between building form and wind loading	
<b>L02</b> Determine bending, shear and deflection for complex support conditions		<b>D2</b> Critically evaluate different materials and their structural efficiency in managing bending, shear and deflection
<b>P3</b> Calculate bending and shear in complex support conditions <b>P4</b> Determine deflection in complex support conditions <b>P5</b> Evaluate structural connections in relation to complex support conditions	<b>M2</b> Discuss the relationship between bending, shear and deflection	
<b>L03</b> Design complex columns and piled foundations based on calculation		
<b>P6</b> Calculate the axial load carrying capacity of complex columns, with eccentric loading <b>P7</b> Calculate the axial load carrying capacity of reinforced concrete piled foundations <b>P8</b> Prepare design information for a structure utilising piled foundations and steel columns	<b>M3</b> Discuss the benefits of using Building Information Modelling in the design workflow	<b>D3</b> Assess the most effective foundation type for a given scenario in terms of ease and speed of construction, economics, safety and environmental factors



Pass	Merit	Distinction
<b>LO4</b> Explore the design of tensile structures		<b>D4</b> Using calculations as well as other research, justify the choice of a tensile structure solution for a given scenario
<p><b>P9</b> Discuss the differences between types of tensile structures</p> <p><b>P10</b> Design a simple tensile structure for a given scenario</p>	<p><b>M4</b> Compare tensile structural solutions to a given scenario</p>	

## Recommended resources

### Textbooks

- ANTHONY, A. et al (2007) *Reynolds's Reinforced Concrete Designer's Handbook*. 11th ed. London: Taylor & Francis.
- DURKA, F. et al (2002) *Structural Mechanics: Loads, Analysis, Design and Materials*. 6th ed. London: Prentice Hall.
- FIONA, C. (2008) *Structural Engineer's Pocket Book*. 2nd ed. Oxford: Butterworth-Heinemann.
- HULSE, R. and CAIN, J. (2000) *Structural Mechanics*. 2nd ed. Palgrave Macmillan.
- MCKENZIE, W. (2003) *Design of Structural Elements*. London: Palgrave Macmillan.
- MOSLEY, H. (2007) *Reinforced Concrete Design*. 6th ed. London: Palgrave.
- OZELTON, E. (2006) *Timber Designers' Manual*. Chichester, West Sussex: Wiley-Blackwell.
- SEWARD, D. (2003) *Understanding Structures: Analysis, Materials, Design*. 3rd ed. London: Palgrave Macmillan.
- SMITH, P. (2001) *An Introduction to Structural Mechanics*. London: Palgrave Macmillan.
- STEEL CONSTRUCTION INSTITUTE (2005) *Steel Design Manual*. 6th ed. Chichester, West Sussex: Wiley-Blackwell.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 8: Mathematics for Construction*

*Unit 14: Building Information Modelling*

*Unit 18: Civil Engineering Technology*

*Unit 27: Construction Technology for Complex Building Projects*

*Unit 28: Further Mathematics for Construction*

*Unit 36: Advanced Building Information Modelling*

*Unit 42: Highway Engineering*

*Unit 43: Hydraulics*

# Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation

<b>Unit code</b>	<b>F/615/1417</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

Modern high-rise, and multi-zone, buildings have complex requirements for heating and cooling. Their scale, number of occupants, and need for better performance and efficiency, means that the design and installation of systems for heating, cooling and ventilation are critical.

This unit is designed to introduce students to the principles of Advanced Heating, Ventilation and Air Conditioning Design & Installation.

Upon completion of this unit, students will be able to understand a broad application of technologies and design techniques used to satisfy the requirements within large commercial or complex/multi-zone buildings.

Topics included in this unit include hydraulic and control strategies for heating, sustainable technologies, ventilation systems for forced air and passive ventilation, complex distribution and plan strategies for air conditioning, and related design and installation factors.

## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Compare the different HVAC systems and technologies that serve large commercial or complex/multi-zone buildings
- 2 Evaluate the design requirements for large commercial or complex/multi-zone buildings when selecting heating, ventilation or air conditioning
- 3 Assess how sustainable design strategies can be integrated into large-scale and complex HVAC systems
- 4 Present a proposal for an advanced HVAC system for a complex/multi-zone building.

## Essential Content

### LO1 Compare the different HVAC systems and technologies that serve large commercial or complex/multi-zone buildings

#### *Heating:*

Sources of heat

Distribution

Heat exchange

Types of heating methods/emitters

Efficient design principles

Renewables

Fuel sources.

#### *Ventilation:*

Central, zonal and local systems

Supply, extract and combined systems

Air handling plan

Filtration

Ductwork

Pressure cascades/containment

Heat recovery and efficient operation.

#### *Air conditioning:*

Sources of cooling

Water and refrigerant distribution

Water-based systems

Refrigerant-based systems

Air-distributed systems

Means of cooling air, dehumidifying, and humidifying

Terminal devices.

#### *Design and installation factors*

**LO2 Evaluate the design requirements for large commercial or complex/multi-zone buildings when selecting heating, ventilation or air conditioning**

*Heating:*

Centralised vs decentralised plant

Temperature grades

Pumps, valves

Boiler selection

Typical schematics for system types.

*Ventilation:*

Requirement for ventilation

Identify specialist air handling components

Air handling unit configuration and build quality

Specialist filtration or extract systems

Constant volume vs variable- or demand-based systems

Specialist HVAC systems

Consider the material requirements for cleaning, hygiene, chemical resistance and fire rating.

*Air conditioning:*

Distribution distance

Terminal devices

Combined ventilation and cooling systems

Temperature and humidity, setpoints.

### LO3 **Assess how sustainable design strategies can be integrated into large-scale and complex HVAC systems**

#### *General:*

National and international regulations and compliance requirements

Improving Energy Performance Certificates and Display Energy Certificates

Theoretical vs actual energy use, and design considerations against client use

BREEAM and LEED: what are they and what do they mean?

Identify credits that may have implications on advanced HVAC designs and plant selections.

#### *Heating:*

Renewable and biofuel sources

Combined heat and power (CHP)

Heat pumps

Solar collectors

Waste heat

Condensing boilers.

#### *Ventilation:*

Heat recovery

Fan and motor technologies

Variable air volume systems and active demand-based.

#### *Cooling:*

Tri-generation

Links to CHP and waste heat

Adiabatic cooling

F-gas regulations

Compressor and control technologies

Free-cooling

High-efficiency refrigerant systems

High-efficiency water systems

Air source vs ground/water, source heat pumps.

**LO4 Present a proposal for an advanced HVAC system for a complex/multi-zone building**

*Heating:*

Plant sizing for large-scale projects

Delta Ts throughout network

Control and turndown of plant

Schematic arrangements for complex and large-scale projects.

*Ventilation:*

Plant sizing for large-scale projects

Air volumes

Operation and control of plant

Schematic arrangements for complex and large-scale projects.

*Cooling:*

Plant sizing for large-scale projects

Water-based cooling

Limitations in refrigerant pipework distances

Control and turndown of plant

Schematic arrangements for complex and large-scale projects.



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Compare the different HVAC systems and technologies that serve large commercial or complex/multi-zone buildings		<b>D1</b> Critically evaluate different advanced HVAC systems and plant choices and how such choices may impact on the building's construction and performance
<b>P1</b> Discuss the common HVAC systems for commercial buildings  <b>P2</b> Review common plant items and distribution methods for advanced HVAC systems	<b>M1</b> Illustrate the operation of a given large or complex building type	
<b>LO2</b> Evaluate the design requirements for large commercial or complex/multi-zone buildings when selecting heating, ventilation or air conditioning		<b>D2</b> Critically evaluate and select the key design and legislative criteria that are required for advanced HVAC engineering design within differing types of buildings and their intended uses
<b>P3</b> Discuss the current legislation and codes of practice that influence the design and selection of advanced HVAC systems  <b>P4</b> Present an evaluation of the key design principles and fundamentals that are required to select advanced HVAC schemes for buildings	<b>M2</b> Analyse the critical relationship between the design fundamentals and legislative requirements that are needed for an effective advanced HVAC design within large and complex buildings	

Pass	Merit	Distinction
<p><b>L03</b> Assess how sustainable design strategies can be integrated into large-scale and complex HVAC systems</p>		<p><b>D3</b> Critically analyse the impact of incorporating sustainable technologies into a HVAC system</p>
<p><b>P5</b> Discuss the economic and legislative drivers for sustainable design in advanced HVAC systems</p> <p><b>P6</b> Assess the main sustainable design considerations for advanced HVAC systems</p>	<p><b>M3</b> Demonstrate how sustainable strategies inform the operation and efficiency characteristics of a HVAC system</p>	
<p><b>L04</b> Present a proposal for an advanced HVAC system for a complex/multi-zone building</p>		<p><b>D4</b> Critically evaluate design proposals for HVAC systems to confirm suitability for a given building type</p>
<p><b>P7</b> Investigate the design considerations and system components that inform the design process for advanced HVAC services</p> <p><b>P8</b> Assess the key design calculations and plant selections that are needed to propose a system design</p> <p><b>P9</b> Produce a design package of work, correctly sized plant and distribution for an advanced HVAC system for a given building type</p>	<p><b>M4</b> Evaluate the efficiency of a HVAC system proposed for a given building type</p>	

## Recommended resources

### Textbooks

CHADDERTON, D. (2012) *Building Services Engineering*. 6th ed. London: Routledge.

HALL, F. and GREENO, R. (2015) *Building Services Handbook*. 8th ed. London: Routledge.

### Links

This unit links to the following related units:

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 14: Building Information Modelling*

*Unit 17: Principles of Public Health Engineering*

*Unit 28: Further Mathematics for Construction*

*Unit 40: Alternative Energy Systems Design & Installation*

*Unit 43: Hydraulics*

## Unit 32: Building Management Systems

<b>Unit code</b>	<b>J/615/1418</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The earliest examples of Building Management Systems are found in large public and commercial premises. For the most part, these were used for automatic control of heating, cooling and, in some instances, security. However, Building Management System applications have broadened in scope and are becoming common in the domestic market, such as extra-low-voltage, intelligent lighting, which is already becoming the norm for many new homes (not exclusively those at the higher end of the market).

An environment controlled by a computer can provide, not only the optimum levels of heat, humidity and lighting for a building and its occupants, but also monitor energy use and contribute to energy conservation. Incorporating Energy Demand Management (EDM) into the Building Management System can facilitate automatic conformance with current energy usage regulations. The advent of the smart phone and low-cost apps has opened the door to truly remote control and monitoring of a building's environment and security. Heating and lighting can be switched on and set by the homeowner long before they reach their own front door.

The aim of this unit is to explore the rapidly growing range of services provided by Building Management System technology and assess its contribution to the renewable energy debate. There is also an opportunity to apply this research by carrying out a design of a Building Management System.

On successful completion the students will be conversant with current and emerging Building Management System technologies, will have developed the tools to evaluate the benefit of a Building Management System and apply their theoretical knowledge to a real-life installation.

## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Evaluate emerging Building Management System technologies
- 2 Assess how a Building Management System can optimise cost and energy usage
- 3 Discuss the differences between Building Management Systems for domestic and non-domestic buildings
- 4 Specify a Building Management System suitable for a large domestic installation.

## Essential Content

### LO1 Evaluate emerging Building Management System technologies

#### *Types of Building Management System:*

Centralised system; a single Central Processing Unit (CPU)

Distributed Intelligence Systems: intelligent outstations with communications channels.

#### *System integration:*

Cloud and web applications, mobile apps, protocols.

#### *Adaptive energy management:*

Conditional logic, human intervention, energy policy management.

### LO2 Assess how a Building Management System can optimise cost and energy usage

#### *Control:*

Regulating equipment performance, electrical voltage

Close control of heating and cooling, and lighting

Energy usage feedback, weather compensation.

#### *Monitoring:*

Develop a monitoring methodology

Develop methodology for cost and energy savings.

#### *Sustainability*

**LO3 Discuss the differences between Building Management Systems for domestic and non-domestic buildings**

*Requirements for domestic installations:*

Smart homes.

*Requirements for non-domestic installations*

*Remote control through smart phone apps*

*Environmental requirements*

**LO4 Specify a Building Management System suitable for a large domestic installation**

*Regulations and standards:*

Health & safety

Building regulations

Manufacturing certifications.

*Client requirements*

*Design:*

Elements of Building Management System design

Suitability of technologies

Protocols and component selection

Commissioning process.

*Proposal:*

Proposal writing

Presentation formats and techniques.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Evaluate emerging Building Management System technologies		<b>D1</b> Justify the use of BMS system in support of greater user control
<p><b>P1</b> Discuss the principles of Building Management System</p> <p><b>P2</b> Explain the different approaches to system integration</p>	<b>M1</b> Compare BMS technologies for a given application	
<b>LO2</b> Assess how a Building Management System can optimise cost and energy usage		<b>LO2, LO3 and LO4</b> <b>D2</b> Justify recommendations for a BMS based on a cost, improved building efficiency and improved performance
<p><b>P3</b> Record, on a data sheet, energy costs and usage for a given set of buildings</p> <p><b>P4</b> Select a Building Management System to optimise cost and energy usage</p> <p><b>P5</b> Justify the selection of a Building Management System in achieving greater sustainability through control and monitoring</p>	<b>M2</b> Analyse variations in energy costs and usage data between two given buildings; one which incorporates a Building Management System and one that does not	
<b>LO3</b> Discuss the differences between Building Management Systems for domestic and non-domestic buildings		
<p><b>P6</b> Research functions, components, software and systems suitable for a large domestic installation</p> <p><b>P7</b> Evaluate how a non-domestic Building Management System would differ from a domestic</p>	<b>M3</b> Compare a BMS for a domestic installation and a non-domestic installation; in terms of cost, functionality, monitoring and design philosophy	



Pass	Merit	Distinction
<b>LO4</b> Specify a Building Management System suitable for a large domestic installation		
<b>P8</b> Prepare a design proposal for a large domestic Building Management System installation  <b>P9</b> Prepare costings for a large domestic Building Management System installation proposal	<b>M4</b> Analyse different strategies for a large domestic Building Management System installation with reference to cost analysis and manufacturers' data	

## Recommended resources

### Textbooks

LEVERMORE, G. (2000) *Building Energy Management Systems: An Application to Heating, Natural Ventilation, Lighting and Occupant Satisfaction*. 2nd ed. London: Spon.

NIZAMIC, F. (2016) *A Smart Energy System for Sustainable Buildings: The Case of the Bernoulliborg*. 1st ed. Lavergne, TN: Amazon CreateSpace.

SINOPOLO, J. (2009) *Smart Buildings Systems for Architects, Owners and Builders*. Oxford: Butterworth-Heinemann.

### Links

This unit links to the following related units:

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 16: Principles of Alternative Energy*

*Unit 17: Principles of Public Health Engineering*

*Unit 25: Management for Complex Building Projects*

*Unit 39: Transport Systems in Buildings*

*Unit 45: Maintenance & Operations*

## Unit 33: Advanced Electrical Design & Installation

<b>Unit code</b>	<b>L/615/1419</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

Across the world, people rely on the ability to use electrical devices to facilitate work, education, and entertainment. The provision of sufficient electrical power relies on the design of systems which are suitable to the application, but are also safe and sustainable. The overall aim of this unit is to support students to develop an understanding of the principles that underpin the design and installation of electrical systems for complex buildings.

Topics covered in this unit include: electrical distribution systems, cabling, lighting systems, electromagnetic compatibility, applying protective measures, equipment installation, building services automation, building system engineering, statutory regulations, Health & Safety.

On successful completion of this unit students will be in a position to be able to assist senior colleagues with electrical systems design and installation. In addition, students will have the advanced knowledge and skills to progress on to a higher level of study.

## Learning Outcomes

By the end of this unit students will be able to:

- 1 Evaluate the principles that underpin the design and installation of power and distribution systems, electromagnetic compatibility equipment and electrical equipment
- 2 Discuss the range of protective measures necessary for the safe installation and operation of electrical systems
- 3 Design an electrical distribution plan for a complex non-domestic building
- 4 Present a report on the national/regional/local standards for technical and Health & Safety regulations that apply to specific building types.

## Essential Content

### LO1 Evaluate the principles that underpin the design and installation of power and distribution systems, electromagnetic compatibility equipment and electrical equipment

*Electrical distribution*

*Lighting systems*

*Power cables and their application*

*System protection*

*Low-voltage switchboards and distribution systems*

*Grounding systems*

*Power-factor correction and harmonic filtering*

*Protection equipment for load circuits*

*Mechanical, electromechanical, and electronic modular devices, timers*

*Operator communication, switching, control, and signalling systems, information and monitoring systems*

*Building control systems*

*Terminology*

*Electromagnetic compatibility (EMC) equipment design*

Compliance with EMC installation rules.

### LO2 Discuss the range of protective measures necessary for the safe installation and operation of electrical systems

*Protection against direct and indirect contact*

*Protection against electric shock under normal conditions*

*Protection against electric shock under fault conditions*

*Protection against overvoltage of atmospheric origin or switching overvoltage in low-voltage systems.*

**LO3 Design an electrical distribution plan for a complex non-domestic building**

*Functional buildings*

*Office buildings*

*Hotels*

*Hospitals and medical practices*

*Industrial buildings and exhibition halls*

*Garages*

*General information on special areas, locations, and installations*

**LO4 Present a report on the national/regional/local standards for technical, and Health & Safety regulations that apply to specific building types**

*Building regulations*

*Health & safety regulations*

Wiring regulations.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Evaluate the principles that underpin the design and installation of power and distribution systems, electromagnetic compatibility equipment and electrical equipment		<b>LO1 and LO2</b>  <b>D1</b> Assess the appropriate protective measures related to the design of systems for power supply, distribution, electromagnetic compatibility and equipment
<b>P1</b> Explore the principles of design and installation for power supply and distribution, electromagnetic compatibility and electrical equipment	<b>M1</b> Compare the installation strategies of different electrical systems in relation to Health & Safety requirements	
<b>LO2</b> Discuss the range of protective measures necessary for the safe installation and operation of electrical systems		
<b>P2</b> Discuss the range of protective measures in normal and fault conditions	<b>M2</b> Illustrate the protective measures necessary for normal and fault conditions in specific systems	

Pass	Merit	Distinction
<p><b>LO3</b> Design an electrical distribution plan for a complex non-domestic building</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Justify the design of an electrical power distribution system and the specification of equipment in relation to statutory regulations and Health &amp; Safety</p>
<p><b>P3</b> Design an electrical distribution plan for a complex non-domestic building</p> <p><b>P4</b> Calculate electrical loads and suitable cabling sizes for an electrical distribution plan</p>	<p><b>M3</b> Specify correctly sized distribution equipment for an electrical distribution plan</p>	
<p><b>LO4</b> Present a report on the national/regional/local standards for technical, and Health &amp; Safety regulations that apply to specific building types</p>		
<p><b>P5</b> Present a report on the range of relevant national/international standards associated with electrical systems and installation</p> <p><b>P6</b> Discuss the national/regional/local regulations related to electrical power and distribution</p>	<p><b>M4</b> Evaluate the relationship between local, regional and national standards related to electrical system design and installation</p>	



## Recommended resources

### Textbooks

GREENO, R. (1996) *Building Services and Design*. Harlow: Longman.

HASSAN, G. (1996) *Building Services*. London: Macmillan.

SEIP, G.G. (2000) *Electrical Installations Handbook*. 3rd ed. Chichester, West Sussex: Wiley-Blackwell.

### Links

This unit links to the following related units:

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 19: Principles of Electrical Design & Installation*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 40: Alternative Energy Systems Design & Installation*

# Unit 34: Advanced Quantities for Complex Building Projects

<b>Unit code</b>	<b>F/615/1420</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

This unit aims to extend the skills gained in *Unit 11: Measurement & Estimating* by developing the composite measurement of more complex elements, components and building services of non-domestic and large-scale buildings.

This unit has been designed to enable students studying construction, civil engineering and building services engineering to apply, analyse and measure a range of components and elements found in large-scale buildings or structures, and to produce quantities within the function of a quantity surveyor.

Topics included within this unit are: estimating techniques, standard methods of measurement, taking-off dimensions, preparation of bills of quantities, estimating data collection and the assembly of an estimate for a work package.

On successful completion of this unit students will be in a position to take-off quantities from drawn information and to prepare estimates for work packages. In addition, students will have the fundamental knowledge and skills to progress on to a higher level of study.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Apply measurement techniques to a range of complex situations
- 2 Produce measured quantities for a range of elements and components on large-scale projects
- 3 Develop relevant preamble and preliminary items to given situations
- 4 Create measured bills of quantities and schedules using both manual and computer techniques.

## Essential Content

### LO1 Apply measurement techniques to a range of complex situations

*Standard techniques applied to the measurement of large-scale projects or developments:*

Production of bills of quantities for work sections; production of schedules; reinforcement; door; window; ironmongery; finishes; measurement of variations on a project; production of sub-contract; production of supply packages; production of final accounts; maintenance works; refurbishment works.

*Demonstration of the selection of techniques used for the production of the above, production of standard formats*

### LO2 Produce measured quantities for a range of elements and components on large-scale projects

*Take-off measurements and produce quantities for the following elements or work sections:*

Complicated foundations incorporating piling and substructures, including brick and concrete basement, sloping site excavations and underpinning; superstructure, including complicated external and internal walls.

*Elements of a building:*

Concrete and steel framed buildings; in-situ, pre-cast and pre-stressed concrete structures; brick and masonry structures; complex flat and pitched roof construction, coverings with metal coverings; internal and external finishes and treatments; internal components such as doors, windows, staircases and kitchen units; differing types of floor systems.

*Building engineering services:*

Plumbing, heating and ventilating, electrical installations, and above and below ground disposal systems.

*Measurement techniques:*

Payments, final account work, different forms of procurement and different types of contractual arrangement.

### **LO3 Develop relevant preamble and preliminary items to given situations**

#### *Production of preamble clauses:*

Contact conditions; parties to the contract; definitions; units; method of measurement; procurement process; extent of works; tender and tender documents.

#### *Production of preliminary clauses:*

Preconstruction activities; statutory approvals; quality procedures; insurance; performance bonds and warranties; possession; Building Information Modelling (BIM); reporting procedures by main contractor; pre-construction Health & Safety plan; site waste management plan (SWMP); contractors items; transport; supervision; accommodation; waste.

#### *Moving and handling:*

Temporary services connections; scaffolding; temporary works.

### **LO4 Create measured bills of quantities and schedules using both manual and computer techniques**

#### *Production of bills of quantities for:*

A complex substructure; a reinforced concrete frame; a structural steel frame; glazing and external facades; concrete composite intermediate floors.

#### *Building Information Modelling*

#### *Schedules*

#### *Quantities*

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Apply measurement techniques to a range of complex situations		<b>LO1 and LO2</b> <b>D1</b> Critically evaluate manual vs digital taking-off techniques
<b>P1</b> Produce a schedule for an element <b>P2</b> Produce a sub-contract package	<b>M1</b> Differentiate between a sub-contract and supply package	
<b>LO2</b> Produce measured quantities for a range of elements and components on large-scale projects		
<b>P3</b> Take-off quantities for a complex substructure element <b>P4</b> Take-off quantities for a complex superstructure element	<b>M2</b> Take-off quantities using digital methodology	
<b>LO3</b> Develop relevant preamble and preliminary items to given situations		<b>D2</b> Critically analyse preamble clauses against stakeholders needs for a project
<b>P5</b> Prepare preamble clauses for a given brief <b>P6</b> Prepare preliminary clauses for a complex project	<b>M3</b> Justify the inclusion of preliminary clauses for a project	
<b>LO4</b> Create measured bills of quantities and schedules using		<b>D3</b> Justify the use of digital or manual taking-off for specific work sections of a bill of quantities
<b>P7</b> Produce a bill of quantities for a work section using manual techniques <b>P8</b> Produce a bill of quantities for a work section using digital techniques	<b>M4</b> Compare the accuracy of manual vs digital taking-off techniques <b>M5</b> Explore the role of Building Information Modelling in the development of bills of quantities	

## Recommended resources

### Textbooks

LEE, S. and TRENCH, W. (2014) *Willis's Elements of Quantity Surveying*. Chichester, West Sussex: Wiley-Blackwell.

OSTROWSKI, S. (2013) *Estimating and Cost Planning Using the New Rules of Measurement*. Chichester, West Sussex: Wiley-Blackwell.

OSTROWSKI, S. (2013) *Measurement Using the New Rules of Measurement*. Chichester, West Sussex: Wiley-Blackwell.

RICS (2012) *NRM 2 Detailed Measurement for Building*. London: RIBA Publishers.

### Websites

<a href="http://www.rics.org">www.rics.org</a>	Royal Institute of Chartered Surveyors (General Reference)
<a href="http://www.designingbuildings.co.uk">www.designingbuildings.co.uk</a>	Designing Buildings Wiki (General Reference)

### Links

This unit links to the following related units:

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 11: Measurement & Estimating*

*Unit 13: Tender & Procurement*

*Unit 14: Building Information Modelling*

*Unit 23: Contracts & Management*

*Unit 24: Project Management*

*Unit 36: Advanced Building Information Modelling*

*Unit 41: Surveying for Conservation, Renovation & Refurbishment*

*Unit 44: Advanced Surveying & Measurement*

*Unit 47: Construction Data Management*

# Unit 35: Alternative Methods of Construction

<b>Unit code</b>	<b>J/615/1421</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The construction industry seeks to be dynamic and forward thinking, but in reality, most buildings are still constructed using many of the same materials and processes that have been utilised for centuries. While there is accumulated knowledge in the use of 'tried-and-tested' methods, these are not always the most efficient or cost effective. Combined with this is the fact that the construction industry is one of the largest contributors to CO2 emissions and is under increasing pressure, and legislation, to improve its processes and practices.

However, the industry also faces other challenges. As one of the most important sectors of the global economy, it is imperative that construction is able to meet the demands for housing, office, institutional and commercial development. Continuing to build, using traditional methods, will not be sufficient. One of the ways in which the sector is exploring how to address sustainability and increase productivity is through the development and implementation of alternative forms of construction.

On successful completion of this unit students will have examined how the construction industry impacts on the environment; explored alternative construction methods which are fit for purpose; government policy implications and Health & Safety constraints associated with alternative construction methods; and designed a fit-for-purpose structure using an alternative construction method.



## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Examine how the construction industry impacts on the environment, and how changes in the industry can create broader social and economic benefits
- 2 Explore alternative construction methods which are fit for purpose in a given context
- 3 Discuss government policy implications and Health & Safety constraints associated with alternative construction methods
- 4 Present a design proposal, utilising a selected alternative construction method.

## Essential Content

### LO1 **Examine how the construction industry impacts on the environment, and how changes in the industry can create broader social and economic benefits**

#### *Environmental protection:*

Features of the environment; global warming; carbon emissions; government and national targets; construction statistics.

#### *Social and economic factors:*

Government influences; construction statistics; housing statistics; affordable homes; urbanisation; greenfield and brownfield sites.

#### *Sustainability protocols:*

Passiv Haus/Passive House

BREEAM

LEED

Code for Sustainable Homes.

### LO2 **Explore alternative construction methods which are fit for purpose in a given context**

*Timber Frame*

*Prefabrication*

*Insulated Concrete Forms (ICFs)*

*Structural Insulated Panels (SIPs)*

*Off-site manufacture*

*Modularisation/Componentisation*

*Robotics*

*Autonomous building*

**LO3 Discuss government policy implications and Health & Safety constraints associated with alternative construction methods**

*Government policy:*

Local/regional/national Planning and Building regulations

Local/regional/national Health & safety legislation.

**LO4 Present a design proposal, utilising a selected alternative construction method.**

*Computer-aided software:*

AutoCAD; Revit; Sketch-up; Photoshop; BIM.

*Computer-aided drawings and details:*

Floor plans; elevations; sections; details; sketches; perspectives; rendered; photo-realisation.

*Presentation and skills:*

Consideration of audience; venue; environment; documentation; resources; time management. Clarity; concision; voice.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Examine how the construction industry impacts on the environment, and how changes in the industry can create broader social and economic benefits</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Evaluate the impact of specifying an alternative construction method on environmental protection</p>
<p><b>P1</b> Explore how the construction industry has an impact on the built environment</p> <p><b>P2</b> Examine how social and economic factors have an effect on the construction industry</p>	<p><b>M1</b> Assess how effective government targets and national statistics have been on environmental protection</p>	
<p><b>LO2</b> Explore alternative construction methods which are fit for purpose in a given context</p>		
<p><b>P3</b> Examine the development of alternative construction methods using historic precedents</p> <p><b>P4</b> Explore alternative construction methods which can be used for commercial or domestic use</p>	<p><b>M2</b> Compare alternative construction methods in terms of effectiveness, cost and performance</p>	

Pass	Merit	Distinction
<p><b>LO3</b> Discuss government policy implications and Health &amp; Safety constraints associated with alternative construction methods</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Justify the use of a chosen alternative construction method</p>
<p><b>P5</b> Examine how government policies have had an impact on building design</p> <p><b>P6</b> Explore the Health &amp; Safety considerations associated with alternative construction methods</p>	<p><b>M3</b> Illustrate the implications and constraints of government policies on the use of alternative construction methods</p>	
<p><b>LO4</b> Present a design proposal, utilising a selected alternative construction method, and explain how it is 'fit for purpose' in the given context</p>		
<p><b>P7</b> Produce a design proposal, using computer-aided drawing tools, utilising alternative construction methods</p> <p><b>P8</b> Present a design proposal that utilises alternative methods of construction</p>	<p><b>M4</b> Evaluate the effectiveness of using computer-aided drawing software and BIM</p>	

## Recommended resources

### Textbooks

COTTERELL, J. and DADEBY, A. (2012) *The Passivhaus Handbook: A Practical Guide to Constructing and Retrofitting Buildings for Ultra-low Energy Performance*. Devon: Green Books.

ELIZABETH, L. and ADAMS, C. (2005) *Alternative Construction: Contemporary Natural Building Methods*. New Jersey: John Wiley & Sons Ltd.

GARBER, R. (2014) *BIM Design: Realising the creative potential of Building Information Modelling*. Chichester: John Wiley & Sons Ltd.

HICKEY, T. (2014) *Construction Technology: Designing Sustainable Homes*.

Dublin: Gill & MacMillan Ltd.

JONES, B. (2015) *Building with Straw Bales: A Practical Manual for Self-Builders and Architects*. Cambridge: Green Books.

LAWSON, M, OGDEN, R. and GOODIER, C. (2014) *Modularisation in the Construction of Buildings*. Florida: Taylor & Francis Group.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 14: Building Information Modelling*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 36: Advanced Building Information Modelling*

*Unit 40: Alternative Energy Systems Design & Installation*

## Unit 36: Advanced Building Information Modelling

<b>Unit code</b>	<b>L/615/1422</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The aim of this unit is to provide students with an understanding of the detailed processes that support and guide construction professionals within the context of Building Information Modelling (BIM). Students will be able to explore the relevance of BIM in the construction industry and understand how the standards and processes that support BIM will enable better information management across the life of a project.

This unit will also explore and detail the relevant changes to existing documentation and information within a project and how this information is developed across the various stages of a project. There are a series of standards that support BIM and students will begin to determine their relevance and utilise them within a BIM process.

The knowledge and skills provided within this unit will enable students to understand the context of BIM within the construction industry and relate this to further study or the realities of today's workplace. This will enable them to be able to effectively determine the relevance of BIM within the construction industry today and how this may affect future processes.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Evaluate the processes and procedures that are required in order to successfully implement BIM within the context of an organisation or a project
- 2 Explore BIM standards and how these support working in the context of a BIM-enabled project
- 3 Discuss key documentation that may be required for a BIM-enabled project
- 4 Assess how BIM can ensure data is created, shared, stored, managed and kept accessible to all stakeholders involved in a project.



## Essential Content

### LO1 Evaluate the processes and procedures that are required in order to successfully implement BIM within the context of an organisation or a project

*BIM implementation methodologies available and how these can begin to positively affect the process of design, construction and operation*

*Identifying organisational or project-specific capability in regard to BIM and how this can be achieved*

*Implementing BIM within the context of an organisation; drivers and enablers*

*Implementing BIM within the context of a project; project specific requirements and information requirements*

*Roles and responsibilities that support BIM working and driven by industry*

*Managing the exchange of information during all key stages of a project and into occupation of the asset*

*The importance of information management*

*Change management principles, both organisational and project-specific.*

### LO2 Explore BIM standards and how these support working in the context of a BIM-enabled project

*Explain how standards are used to allow for a consistent framework on a BIM-enabled project*

*Explain and list the relevant BIM standards that support BIM in the context of the UK and determine how they can be utilised during a project*

*Understand the importance of managing the BIM process via guidance by industry standards*

*The Information Delivery Cycle in the context of PAS 1192-2 or other international standards*

*Standards that support BIM, both regional and international*

*The importance of data drops and information exchanges*

*Security and management of sensitive information surrounding BIM*

*COBie and BIM; the importance of a consistent framework to share relevant data across a project lifecycle*

*Asset management and BIM*

*Facilities management and BIM*

*Commercial suite of documents supporting BIM (e.g. BIM protocol, BIM and IP and the role of information management)*

**LO3 Discuss key documentation that may be required for a BIM-enabled project**

*Understanding the Organisational Information Requirements and their relevance to particular project needs*

*The Asset Information Requirements that relate to the organisation*

*The importance of a clearly defined set of Employer's Information Requirements*

*The terminology surrounding information required within a Built Asset Security Strategy*

*A BIM Execution Plan*

*Project Execution Planning and management*

*The Project Information Model*

*The Asset Information Model*

*The importance of contracts and legal requirements in regard to BIM.*

**LO4 Assess how BIM can ensure data is created, shared, stored, managed and kept accessible to all stakeholders surrounding a project**

*Validation of data across varying stages of a project and ensuring the information gathered is adequate and correct*

*Supply chain assessment and skill requirements*

*Proof of capability and BIM*

*The standards, methods and procedures that support BIM*

*Structure of file formats, naming and types*

*The importance of a Common Data Environment*

*The Master Information Delivery Plan*

*Design responsibilities and level of definition*

*Understanding how to manage a Digital Plan of Work.*

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Evaluate the processes and procedures that are required in order to successfully implement BIM within the context of an organisation or a project</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Critically analyse the importance of a BIM implementation plan that assesses the capability of the organisation in regard to BIM and how effective information delivery can support this in the context of a project</p>
<p><b>P1</b> Evaluate the variety of BIM implementation methods that can be undertaken in regard to a project</p> <p><b>P2</b> Evaluate the importance of people, processes and technology in regard to BIM implementation</p>	<p><b>M1</b> Analyse an example of how BIM can be implemented within an organisation</p>	
<p><b>LO2</b> Explore BIM standards and how these support working in the context of a BIM-enabled project</p>		
<p><b>P3</b> Discuss how the use of standards can provide a consistent framework for the implementation of BIM and BIM-enabled systems</p> <p><b>P4</b> Evaluate key BIM standards that are recognised globally</p>	<p><b>M2</b> Review BIM standards and how these are affecting BIM on a global scale</p>	

Pass	Merit	Distinction
<p><b>LO3</b> Discuss key documents that may be required for a BIM-enabled project</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Analyse how the use of key documents and processes enabled by these documents can ensure that information is developed and managed intelligently as part of a BIM-enabled project</p>
<p><b>P5</b> Discuss the Asset Information Model and how it can be managed and utilised</p> <p><b>P6</b> Evaluate the BIM Execution Plan and the importance of ensuring it is clear, concise and easily understood by all members of the design team</p>	<p><b>M3</b> Analyse the importance of a BIM Execution Plan and explain how this document is managed, updated and utilised within a BIM project</p>	
<p><b>LO4</b> Assess how BIM can ensure data is created, shared, stored, managed and kept accessible to all stakeholders surrounding a project</p>		
<p><b>P7</b> Discuss the term 'Level of Definition' in the context of BIM</p> <p><b>P8</b> Assess the importance of defining clear roles and role requirements regarding a BIM project</p>	<p><b>M4</b> Analyse the recommended roles and requirements needed in the context of BIM and how these will ultimately aid the development of a project at all stages</p>	

## Recommended resources

### Textbooks

EASTMEN, C., TEICHOLZ, P., SACKS, R. and LISTON, K. (2011) *BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors*. 2nd ed. Oxford: John Wiley & Sons Inc.

FAIRHEAD, R. (2013) *Information Exchanges: RIBA Plan of Work 2013 Guide*. London: RIBA Publishing.

HOLZER, D. (2016) *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering and Construction*. Oxford: John Wiley and Sons Inc.

MORDUE, S., PHILP, D. and SWADDLE, P. (2015) *Building Information Modelling for Dummies*. Oxford: John Wiley & Sons Inc.

SAXON, R. (2016) *BIM for Construction Clients*. London: RIBA Publishing.

SHEPHERD, D. (2015) *BIM Management Handbook*. London: RIBA Publishing.

### Websites

<a href="http://www.theb1m.com">www.theb1m.com</a>	The B1M (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group 'COBie UK 2012' (General Reference)
<a href="http://www.thenbs.com">www.thenbs.com</a>	NBS 'BIM (Building Information Modelling)' (General Reference)

## **Links**

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 4: Construction Practice & Management*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 14: Building Information Modelling*

*Unit 24: Project Management*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 27: Construction Technology for Complex Building Projects*

*Unit 47: Construction Data Management*

# Unit 37: Environmental Assessment & Monitoring

<b>Unit code</b>	<b>R/615/1423</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The construction industry is one of the least sustainable industries in the world; using around half of all the resources that humankind consumes. Yet society depends on construction to grow; making it increasingly important to find ways to reduce its impact. Environmental assessment methods were conceived in order to drive improvements in the built environment. They provide common methodologies that enable the environmental impact of buildings and building products to be measured, evaluated and reduced.

This unit explores the important role that environmental assessment and monitoring plays in reducing the environmental impact of the built environment.

On successful completion of this unit students will be able to undertake an environmental assessment of a building and compare its performance against other similar buildings. Students will understand the types of environmental impact that a building can have and how this affects the environment over time. They will evaluate the different environmental assessment methods that exist, and understand the motivations, methods and differences between them.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Discuss what is meant by sustainability and its relevance to the built environment
- 2 Compare the ways that sustainability in construction can be quantified, assessed and monitored, and how this can be used to drive change in the construction industry
- 3 Evaluate the features and drivers behind different environmental assessment methods
- 4 Carry out an environmental assessment on a building; comparing its performance with similar buildings.



## Essential content

### LO1 **Discuss what is meant by sustainability and its relevance to the built environment**

*What is sustainability?*

The meaning of sustainability

The changes to our global climate and their causes and consequences

The concept of the three pillars of sustainability.

*The impact of the construction industry:*

What makes the built environment so unsustainable?

Why is it important to balance the need for buildings with their impact on the environment?

What are the barriers to sustainability faced by the construction industry?

### LO2 **Compare the ways that sustainability in construction can be quantified, assessed and monitored, and how this can be used to drive change in the construction industry**

*Quantifying, measuring and evaluating sustainability:*

Quantitative measures of sustainability

Qualitative measures of sustainability.

*Bringing about change in the built environment:*

'Top-down' sustainability: bringing about change through regulation

'Bottom-up' sustainability: bringing about change through the market.

### **LO3 Evaluate the features and drivers behind different environmental assessment methods**

#### *Building level schemes:*

What are the different industry standard assessment methods used for evaluating the environmental impact of buildings?

How do these schemes differ in the relative importance they give to different areas of concern?

#### *Component level schemes:*

What are the different industry standard assessment methods used for evaluating the environmental impact of materials and components?

How do these relate to and feed into building level assessment methods?

### **LO4 Carry out an environmental assessment on a building; comparing its performance with similar buildings**

#### *Selecting an environmental assessment method:*

Understand the needs and aspirations of the project and determine what the project's sustainability focus will be

Use research carried out as part of LO3 to select the most appropriate environmental assessment method to use.

#### *Project assessment:*

Carry out the assessment to rate the environmental impact of the project

Identify the most effective ways the project could improve its environmental impact

Compare the costs and benefits of the project from an economic, social and environmental perspective with other similar buildings.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Discuss what is meant by sustainability and its relevance to the built environment		<b>D1</b> Critically evaluate how governments seek to address sustainability through legislation
<b>P1</b> Discuss the 'three pillars of sustainability' and the impact humankind is having on the environment  <b>P2</b> Analyse the ways in which buildings are unsustainable and the barriers to sustainability in the construction industry	<b>M1</b> Analyse how the 'three pillars of sustainability' are interrelated, and why it is important for the built environment to balance these	
<b>LO2</b> Compare the ways that sustainability in construction can be quantified, assessed and monitored; evaluating how this can be used to drive change in the construction industry		<b>D2</b> Critically evaluate assessment methods and how they aim to overcome the barriers to sustainable construction
<b>P3</b> Compare quantitative and qualitative measures of sustainability  <b>P4</b> Compare 'bottom-up' and 'top-down' approaches to driving sustainability	<b>M2</b> Examine how different approaches to sustainability drive the construction industry to reduce its environmental impact	

Pass	Merit	Distinction
<p><b>L03</b> Evaluate the features and drivers behind different environmental assessment methods</p>		<p><b>L03 and L04</b></p> <p><b>D3</b> Critically evaluate how environmental assessment methods respond to different environmental concerns and improve the performance of the building</p>
<p><b>P5</b> Compare industry standard building-level environmental assessment methods and identify their particular areas of emphasis</p> <p><b>P6</b> Evaluate different methods of evaluating the environmental impact of materials and components, and how these relate to building level schemes</p>	<p><b>M3</b> Analyse the various environmental assessment methods and their approaches towards reducing a building's impact</p>	
<p><b>L04</b> Carry out an environmental assessment on a building; comparing its performance with similar buildings.</p>		
<p><b>P7</b> Assess the environmental performance of a given building using an industry standard environmental assessment method</p> <p><b>P8</b> Compare a given building's environmental performance with other similar buildings</p>	<p><b>M4</b> Examine how the results of the environmental assessment can be used to improve the environmental performance of the building</p>	

## Recommended resources

### Textbooks

- BERGE, B. (2009) *The Ecology of Building Materials*. 2nd ed. Abingdon: Routledge.
- HALLIDAY, S. (2008) *Sustainable Construction*. 2nd ed. Oxford: Butterworth-Heinemann.
- KUBBA, S. (2012) *Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes*. 1st ed. Oxford: Butterworth-Heinemann.

### Websites

<a href="http://www.breeam.com">www.breeam.com</a>	BRE-BREEAM (General Reference)
<a href="http://www.usgbc.org">www.usgbc.org</a>	Leadership in Energy and Environmental Design (General Reference)
<a href="http://www.gbca.org.au/green-star">www.gbca.org.au/green-star</a>	Green Building Council Australia – Green Star (General Reference)
<a href="http://estidama.upc.gov.ae">estidama.upc.gov.ae</a>	Abu Dhabi Urban Planning Council – Estidama (General Reference)
<a href="http://www.passivehouse.com">www.passivehouse.com</a>	Passive House Institute (General Reference)

### Links

This unit links to the following related units:

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 16: Principles of Alternative Energy*

*Unit 17: Principles of Public Health Engineering*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 40: Alternative Energy Systems Design & Installation*

# Unit 38: Personal Professional Development

<b>Unit code</b>	<b>Y/615/1424</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

As a professional, learning is a continuous and lifelong process. Within the construction industry there are constant changes in technology, materials, processes, legislation and practice. In order to remain up-to-date, it is necessary to recognise the potential of both structured, classroom-based learning and the learning that is gained through professional activities 'on the job'.

This unit provides a framework in which students have the opportunity to reflect upon and contextualise the learning that they gain from working within the industry. In co-ordination with tutors and their employer, students will define the scope, duration and content of their expected work-based learning experience. Throughout the period of their work-based learning experience, students will be expected to record and reflect upon their own learning.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Assess personal learning needs and opportunities within the context of employment
- 2 Plan and manage own personal learning journey, through consultation with employer and tutor/instructor
- 3 Record personal progress and the feedback of others; responding as appropriate to own future development
- 4 Evaluate own learning, based on personal experience and comments from others, in order to plan for the future.

## Essential content

### LO1 **Assess personal learning needs and opportunities within the context of employment**

#### *Learning styles:*

Visual, aural, verbal, physical, logical, social, solitary

Identifying own learning style.

#### *Continuous Professional Development (CPD):*

Training vs development

Personal need vs employer need.

#### *Identifying personal needs:*

Skills audit

Future plans.

#### *Employer needs:*

Skills gaps

Company goals.

### LO2 **Plan and manage own personal learning journey, through consultation with employer and tutor/instructor**

#### *Setting goals:*

SMART goals (specific, measurable, attainable, relevant, time-bound)

Learning goals vs employment goals.

#### *Learning plan:*

Goals

Actions

Resources.



**LO3 Record personal progress and the feedback of others; responding as appropriate to own future development**

*Employer feedback*

360-degree feedback

Performance management.

*Learning/development record*

**LO4 Evaluate own learning, based on personal experience and comments from others, in order to plan for the future**

*Reflective practice:*

Kolb: Learning Cycle

Gibbs: Reflective Model

Brookfield: '3 Lenses'.

*Evaluating success:*

Measurement

Learning from failure.

*Future planning:*

CPD and lifelong learning

Personal Development Planning (PDP)

Career goals, personal goals, company goals.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Assess personal learning needs and opportunities within the context of employment		<b>LO1 and LO2</b> <b>D1</b> Justify personal development plans in relation to employer needs, identifying resource requirements and time commitments of self and others
<b>P1</b> Analyse prior learning to identify potential areas for development  <b>P2</b> Review employer operations in order to identify training/development opportunities  <b>P3</b> Undertake a skills audit to define areas of personal development/training needs	<b>M1</b> Discuss personal training/development needs with employer needs/goals	
<b>LO2</b> Plan and manage own personal learning journey, through consultation with employer and tutor/instructor		
<b>P4</b> Develop a personal development plan  <b>P5</b> Develop SMART goals to meet personal and employer needs  <b>P6</b> Present a personal development plan to an employer and tutor	<b>M2</b> Compare the expectations of self, employer and tutor to establish areas of commonality and divergence	

Pass	Merit	Distinction
<p><b>LO3</b> Record personal progress and the feedback of others; responding as appropriate to own future development</p>		
<p><b>P7</b> Manage own personal development through the course of the work-based learning experience</p> <p><b>P8</b> Periodically review own progress and development</p>	<p><b>M3</b> Reflect on instances of successful convergence of own goals and company goals, and instances of divergent goals</p>	<p><b>LO3 and LO4</b></p> <p><b>D2</b> Critically assess own learning and development, in order to communicate examples of good practice and improvement for the future</p>
<p><b>LO4</b> Evaluate own learning, based on personal experience and comments from others, in order to plan for the future</p>		
<p><b>P9</b> Assess own learning and development through reflection and 360-degree feedback</p> <p><b>P10</b> Prepare a plan for future development in relation to career goals</p>	<p><b>M4</b> Evaluate career goals in relation to future learning and professional development needs</p>	

## Recommended resources

### Textbooks

BOLTON, G. (2014) *Reflective Practice Writing and Professional Development*. London: Sage Publications Ltd.

COTTRELL, S. (2015) *Skills for Success: The Personal Development Planning Handbook*. London: Palgrave Macmillan.

HELYER, R. (2015) *The Work-based Learning Student Handbook*. London: Palgrave Macmillan.

MOON, J.A. (2006) *Learning Journals: A Handbook for Reflective Practice and Professional Development*. London: Routledge.

MEGGINSON, D., WHITAKER, V. and CHARTERED INSTITUTE OF PERSONNEL AND DEVELOPMENT (2007) *Continuing Professional Development*. London: Chartered Institute of Personnel and Development.

PRITCHARD, A. *Ways of Learning: Learning Theories and Learning Styles in the Classroom*. London: Routledge.

RAELIN, J.A. (2008) *Work-based Learning: Bridging Knowledge and Action in the Workplace*. London: Jossey-Bass.

SCHÖN, D.A. (1983) *The Reflective Practitioner: How Professionals Think in Action*. New York: Basic Books.

TARRANT, P. (2013) *Reflective Practice and Professional Development*. London: Sage.

THOMPSON, S. and THOMPSON, N. (2008) *The Critically Reflective Practitioner*. London: Palgrave Macmillan.

### Links

This unit links to the following related units:

*Unit 1: Individual Project*

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 22: Group Project*

*Unit 24: Project Management*

## Unit 39: Transport Systems in Buildings

<b>Unit code</b>	<b>T/615/1446</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The success of today's modern high-rise buildings is the ability to transport its occupants vertically and horizontally in a safe and efficient manner. This unit will examine such systems in detail and their integration into the overall structural elements of the building that supports them.

The overall aim of this unit is to give project managers, in building services, a working knowledge of lifts, escalators and other forms of access arrangements with a building. The principle person responsible for this is often the building services engineer and it is their responsibility to ensure that such systems operate efficiently and safely for all stakeholders.

On successful completion of this unit students will be in a position to understand the requirements for the installation of a transport system within a building that would be installed by a specialist sub-contractor. In addition, students will have the fundamental knowledge and skills to progress on to a higher level of study in services engineering.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Discuss the functional requirements for circulation within a proposed building design
- 2 Determine traffic planning and equipment selection criteria
- 3 Discuss the installation of escalators and moving walkways into a building
- 4 Evaluate the installation of lift systems.

## Essential content

### LO1 Discuss the functional requirements for circulation within a proposed building design

#### *Clients' requirements:*

Private and public access arrangements; goods deliveries; desired circulation; access limits; disability access arrangement requirements; location of transport arrangements; energy use; sustainable design; capacity; circulation elements; future expansion planning; emergency evacuation policies and statutory requirements; major circulation flows; non-discrimination requirements; principles of inclusive design.

#### *Human factors:*

Volume and timing of circulation; circulation zones; reaction to evacuation alarms; size of occupancy; weight; body sway; evacuation time requirements; disabled access; speed of access; initial method of access; motor car, train, tram, tube, bicycle, motorbike, parking and access arrangements from garages; speed of pedestrians; age and frailty; religion in terms of separated sexes; safety considerations; slips, trips and falls; even flooring; reading signage; personal comfort zones; personal space; human behaviour; density of occupation of transport systems; distances, social, personal, public and intimate.

## LO2 **Determine traffic planning and equipment selection criteria**

### *Factors:*

Start times of building occupancy; peak congestion times; traffic patterns, vertical and horizontal; line of sight; definitions; signage to be used throughout building; handling capacity of the lift against size of lift to be accommodated; acceptable waiting times during peak access/egress; quality of service required; maximum height to lift passengers; aesthetics; crowding limits; circulation efficiency; fire and safety considerations; speed of operation; round trip calculations; traffic simulation and analysis data feed into design.

### *Equipment selection:*

Costs, capital and lifetime maintenance; statutory compliance costs; inspection and testing certification; quality, reliability and safety; lift/escalator capacity; inclination requirements; height; horizontal distances to be travelled; speed of lift; lift shaft size; finishes available; type of lifting arrangements; functionality e.g. hospital patients; maintenance call-out service locations; car design; control room and machine room requirements; width of escalators; finishes and fixtures; car ceilings, handrails, bumpers, doors and frames.

## LO3 **Discuss the installation of escalators and moving walkways into a building**

### *Escalator installation:*

Structural support requirements; design and detail of principle components; drive systems; energy requirements; emergency stop procedures; safety devices; signage; fire precaution measures; types of balustrade; inclination distance requirements; stair width; capacity; speed; variable; two-way reversible direction; installation and structural connections; testing and commissioning; pre-engineered off-the-shelf applications; custom designed; lifecycle maintenance requirements; final use, public or private.

### *Moving walkways:*

Structural requirements in terms of installation and support; design details for installation; motor and energy requirements; use; load carrying capacity; width of walkway; maximum travel distances; speed of travel; emergency stop procedures; signage; balustrade details; handrail heights; access/egress transition; distances between walkways; space and maintenance access arrangements; testing and commissioning.



## LO4 Evaluate the installation of lift systems

### *Design of lift installation:*

Type: passenger lift; goods and passenger lifts; permanent or construction lifting installation; goods lift only; observation lift in tall structures; service lift; motor vehicle lifts; design details and installation drawings; structural requirements; fire precaution requirements; car design, single, double decker.

### *Type of power:*

Type of drive: hydraulically driven; electric traction; counter weight driven; associated suspension and roping systems; braking systems; speed controllers.

### *Lift controls:*

Controller technology for call systems; DC and AC drive systems; energy saving sustainable considerations; door operation control; single lift control; multiple lift control; group traffic controller; fire and evacuation control by authorities; statutory requirements.

### *Electrical installation:*

Mains cable installation; isolation to lift systems; signage and diagrammatic symbols; emergency lighting; access and maintenance lighting to lift shaft and plant rooms; standby power supplies in event of mains failure; lift car lighting requirements; lift emergency phone installation and connection; lift remote alarms installation; CCTV requirements for clients.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Discuss the functional requirements for circulation within a proposed building design		<b>D1</b> Evaluate the performance criteria of a transport installation in meeting statutory regulations
<b>P1</b> Assess stakeholder requirements for movement within a building <b>P2</b> Explain the factors that affect the selection of a transportation system	<b>M1</b> compare stakeholders' needs with statutory requirements	
<b>L02</b> Determine traffic planning and equipment selection criteria		<b>D2</b> Critically evaluate the design of a transportation system in meeting the traffic planning analysis
<b>P3</b> Assess the factors that affect the level of traffic for a transport system <b>P4</b> Examine the criteria that affect the selection of lifting and transportation equipment	<b>M2</b> Contrast traffic requirements against the performance of selected equipment	
<b>L03</b> Discuss the installation of escalators and moving walkways into a building		<b>L03 L04</b> <b>D3</b> Critically analyse a vertical transportation system with regard to fire-fighting use
<b>P5</b> Explore the installation of escalator systems <b>P6</b> Discuss the installation of moving walkways	<b>M3</b> Analyse the installation of an escalator or moving walkway system against stakeholders' needs	
<b>L04</b> Explain the installation of lift systems		
<b>P7</b> Examine the installation of a lift system <b>P8</b> Detail the design of the structural elements in support of a lift installation	<b>M4</b> Evaluate the lift installation in meeting the requirements of the building regulations in terms of fire and fire fighting	

## Recommended resources

### Textbooks

BARNEY, G. (2016) *Elevator Traffic Handbook: Theory & Practice*. London: Taylor & Francis.

CIBSE (2015) *CIBSE Lifts Group & Guide Steering Committee*. London: Taylor & Francis.

### Websites

[www.elevatorworld.com](http://www.elevatorworld.com)

Elevator World, Inc.  
(General Reference)

[www.cibse.org](http://www.cibse.org)

Chartered Institution of Building  
Services Engineers  
(General Reference)

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 18: Civil Engineering Technology*

*Unit 30: Advanced Structural Design*

*Unit 32: Building Management Systems*

# Unit 40: Alternative Energy Systems Design & Installation

<b>Unit code</b>	<b>D/615/1425</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The demand for energy – to run electrical devices, heat and cool buildings, and maintain industry – continues to grow and places considerable strain on the natural environment. The pressures of supporting economic growth, while seeking to minimise our environmental impact, has driven the research and development of new sources of energy.

The objective of this unit is to provide students with the knowledge and skills necessary to implement suitable alternative energy technologies and understand their economic, social and environmental benefit within a broader context.

Topics covered in this unit will include: energy systems, solar power systems, energy conservation, passive solar heating, wind energy, ocean energy technologies, hydro and micro-hydro turbines, geothermal energy, air pollution abatement, carbon dioxide sequestration and carbon trading economics.

On successful completion of this unit students will be in a position to be able to assist senior colleagues with alternative energy system design and installation. In addition, students will have the advanced knowledge and skills to progress to a higher level of study.

## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Calculate a load duration curve from given data relating to a supply situation
- 2 Evaluate the principles that underpin the design and installation of alternative methods of power generation and distribution
- 3 Discuss the social, political, environmental and economic factors related to alternative energy systems
- 4 Report on the selection of an alternative energy scheme for a given context.

## Essential Content

### LO1 **Calculate a load duration curve from given data relating to a supply situation**

*Calculate the load factor and diversity factor from load curves*

*Determine a suitable cost of energy*

*Deduce the load duration curve from the load curve*

### LO2 **Evaluate the principles that underpin the design and installation of alternative methods of power generation and distribution**

*Solar power*

*Passive solar heating*

*Wind energy technology*

*Ocean energy technology*

*Hydroelectric and micro-hydro turbine power*

*Geothermal energy*

*Combined heat and power (CHP)*

*District energy.*

### LO3 **Discuss the social, political, environmental and economic factors related to alternative energy systems**

*Global warming:*

*Climatic and atmospheric changes*

*Air pollution abatement*

*Carbon dioxide sequestration and carbon trading economics*

*National policies*

*International agreement/targets.*

**LO4 Report on the selection of an alternative energy scheme for a given context**

*Building types and their needs*

*Technical aspects*

*Economical aspects*

*Social aspects*

*Environmental aspects.*

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Calculate a load duration curve from given data relating to a supply situation		<b>LO1 and LO2</b> <b>D1</b> Define a strategy for alternative power generation, based on optimal load duration
<b>P1</b> Calculate and draw typical load and load duration curves from given data relating to a supply situation	<b>M1</b> Illustrate changes in load, over time, for varying supply situations	
<b>LO2</b> Evaluate the principles that underpin the design and installation of alternative methods of power generation and distribution		
<b>P2</b> Analyse a given energy generation system in order to define an installation strategy <b>P3</b> Discuss the installation requirements of a given alternative energy generation system	<b>M2</b> Compare different systems of power generation in order to select a suitable system	
<b>LO3</b> Discuss the social, political, environmental and economic factors related to alternative energy systems		<b>LO3 and LO4</b> <b>D2</b> Justify the selection of an alternative energy system, for a given context, which recognises the social, political and economic factors that influence the selection process
<b>P4</b> Discuss the ways in which social, political and economic factors influence the discourse around the environment and alternative energy	<b>M3</b> Evaluate the ways in which global warming and carbon emissions impact on the adoption of alternative energies	
<b>LO4</b> Report on the selection of an alternative energy scheme for a given context		
<b>P5</b> Specify an alternative energy generation scheme for a given context <b>P6</b> Illustrate an alternative energy scheme for a given context, highlighting the key factors informing the selection	<b>M4</b> Present a comparison of different alternative energy systems in support of the decision for a selected system	



## Recommended resources

### Textbooks

GEKIVORKIAN, P. (2010) *Alternative Energy Systems in Building Design*. London: McGraw-Hill.

GREENSOURCE (2008) *The Magazine of Sustainable Design Emerald Architecture: Case Studies in Green Building*. London: McGraw-Hill.

HASELBACH, L. (2010) *The Engineering Guide to LEED – New Construction: Sustainable Construction for Engineers*. London: McGraw-Hill.

LUCKETT, K. (2009) *Green Roof Construction and Maintenance*. London: McGraw-Hill.

MELAVER, M. and MUELLER, P. (2009) *The Green Building Bottom Line: The Real Cost of Sustainable Building*. London: McGraw-Hill.

NICHOLS, A. and LAROS, J. (2009) *Inside the Civano Project: A Case Study of Large-Scale Sustainable Neighborhood Development*. London: McGraw-Hill.

TWIDELL, J. and WEIR, T. (2005) *Renewable Energy Resources*. 2nd ed. London: Routledge.

YUDELSON, J. (2008) *Green Building Through Integrated Design*. London: McGraw-Hill.

YUDELSON, J. (2009) *Greening Existing Buildings*. London: McGraw-Hill.

### Links

This unit links to the following related units:

*Unit 3: Science & Materials*

*Unit 8: Mathematics for Construction*

*Unit 16: Principles of Alternative Energy*

# Unit 41: Surveying for Conservation, Renovation & Refurbishment

<b>Unit code</b>	<b>H/615/1426</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

A building survey is a systematic inspection of a property to record its size and condition at any given time. The surveyor records the methods of construction, key features and their condition. What if the building is 300 years old, or even 100 years old; is it the same process, are the same skills and knowledge required?

This unit will introduce students to the process, techniques and underpinning knowledge required to undertake a survey of a building. The unit will focus on surveying the condition of the fabric rather than a measured survey. However, where appropriate, consideration will be given to taking measurements to record the condition of the building. The unit will consider the different styles and methods of construction, how to analyse them and how they typically fail over time. The unit takes a practical approach, drawing on the initial learning and knowledge and applying it to surveying a property and producing a professional, detailed survey report for a variety of end users.

Successful completion of this unit will provide students with a good understanding of the built environment and the methods of surveying it. The unit will be useful to any students working in the conservation, conversion and adaptation fields. However, those following a management or technician route would benefit from the knowledge of historic methods of construction.

## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Examine an existing building to determine its character
- 2 Investigate methods of building construction
- 3 Assess mechanisms of failure and deterioration in historic buildings
- 4 Produce a building survey report in support of a proposed conservation, renovation or refurbishment scheme.

## Essential Content

### LO1 Examine an existing building to determine its character

*Residential property:*

Private residential

Multi-occupancy.

*Commercial buildings:*

Retail buildings/property

Office buildings/interiors.

*Cultural buildings:*

Museums/galleries

Performance halls.

*Industrial buildings*

*Issues for historic buildings:*

Architectural periods

Preservation/conservation vs restoration.

### LO2 Investigate methods of building construction

*Framed construction methods:*

Iron and steel frame methods

Framed construction methods of constructing infill panels and walls.

*Mass construction methods.*

Roof construction

Roof covering.

### LO3 **Assess mechanisms of failure and deterioration in historic buildings**

#### *Structural failure:*

Lateral and vertical movement, subsidence, material failure, overloading, component removal, alterations, poor design, change of use.

#### *Deterioration due to water penetration:*

Damp, timber rot (dry and wet), corroded metals, erosion, freeze thaw, corrosion.

#### *Other mechanisms of failure and deterioration:*

Fungal attack, insect attack on timber and masonry, fire, thermal movement, human impact.

### LO4 **Produce a building survey report in support of a proposed conservation, renovation or refurbishment scheme**

#### *Undertaking a building survey:*

Health & safety considerations: dangerous structures, deleterious materials, fragile structures.

#### *Statutory regulations for historic buildings*

#### *Recording information:*

Detailed notes, sketches, photographs, measurements, levels, electronic data collection methods.

#### *Presenting information:*

Survey report styles and formats.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Assess an existing building to determine its character		<b>LO1 and LO2</b> <b>D1</b> Critically analyse the relationship between architectural style, building type and materials in a given building
<b>P1</b> Discuss different building types and their characteristics	<b>M1</b> Evaluate the development of architectural styles in relation to cultural context	
<b>P2</b> Discuss the difference between conservation and restoration in historic buildings		
<b>LO2</b> Investigate methods of building construction		
<b>P3</b> Explore the methods of construction in given buildings	<b>M2</b> Examine the development of methods of construction and the use of different materials	
<b>LO3</b> Assess mechanisms of failure and deterioration in historic buildings		<b>LO3 and LO4</b> <b>D2</b> Justify a proposal for conservation/renovation or restoration of a historic building, with reference to surveyed defects
<b>P4</b> Differentiate between mechanisms of failure and deterioration in the fabric of a building	<b>M3</b> Evaluate the condition, defects and determine reasons for failure in a given building	
<b>P5</b> Analyse building defects and explain the mechanism of their failure		
<b>LO4</b> Produce a building survey report in support of a proposed conservation, renovation or refurbishment scheme		
<b>P6</b> Plan and undertake a survey of an historic building	<b>M4</b> Record the construction methods and condition of an historic building	
<b>P7</b> Produce a professional building survey report of an historic building		
<b>P8</b> Discuss the statutory responsibilities associated with historic buildings		

## Recommended resources

### Textbooks

FORSYTH, M. *Structures and Construction in Historic Building Conservation*. Chichester, West Sussex: Wiley-Blackwell.

GLOVER, P.V. (2013) *Building Surveys*. London: Routledge.

HOXLEY, M. (2009) *Good Practice Guide: Building Condition Surveys*. London: RIBA.

HOXLEY, M. (2016) *Building Condition Surveys*. London: RIBA.

KOSTOF, S. (2010) *A History of Architecture: Settings and Rituals*. Oxford: Oxford University Press.

MCCAIG, I., ABREY, G. and ENGLISH HERITAGE *Conservation Basics*. Farnham: Ashgate Publishing Limited.

NOY, E.A. and DOUGLAS, J. (2011) *Building Surveys and Reports*. Chichester, West Sussex: Wiley-Blackwell.

WATT, D. (2011) *Surveying Historic Buildings*. 2nd ed. London: Routledge.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 11: Measurement & Estimating*

*Unit 14: Building Information Modelling*

*Unit 15: Principles of Refurbishment*

*Unit 25: Management for Complex Building Projects*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 36: Advanced Building Information Modelling*

*Unit 44: Advanced Surveying & Measurement*

## Unit 42: Highway Engineering

<b>Unit code</b>	<b>K/615/1427</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The quick and flexible means of transport, afforded to us by motor vehicles, has transformed modern life. This ease of mobility is afforded by the construction and maintenance of our road system. The increased volume of traffic and the need to have an efficient road network to transport resources requires us to become more proactive in developing innovative highway solutions. In recent years, we have seen the introduction of 'smart motorways' and 'guided bus-ways'; however, we will require more creative and resourceful solutions for the future.

This unit explores the planning, design, construction and maintenance of our road infrastructure; including the supporting structures such as tunnels, bridges and full pavement construction.

On successful completion of this unit students will be able describe a new route process for a highway as well as explaining civil engineering aspects, including pavement types. They will also be able appraise improvements to the existing road infrastructure.



## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Evaluate how a new highway route is identified, planned and designed
- 2 Assess the methods of earthwork operations, bridges and tunnelling which are used in connection with the provision of highways
- 3 Justify the selection of pavement construction type for a given highway provision
- 4 Present a report that specifies improvement that can be made to a given highway infrastructure project, including maintenance techniques and planning.

## Essential content

### LO1 Evaluate how a new highway route is identified, planned and designed

#### *Highway identification and planning:*

The techniques used for the assessment of potential traffic volumes

Understanding of the different variables which affect potential traffic volumes

Land acquisition procedures for preferred routes, including alignment design

Public consultation arrangements, including Environmental Impact Assessment

Funding arrangements, including any proposed tolls, contributions or other revenue sources.

#### *Highway design:*

Horizontal and vertical alignment design of roads

Environmental Impact Assessment requirements within the design

Proposed assessment of interchanges with existing infrastructure, including bridges, tunnels and junctions

Provision and integration of any electronic toll collection infrastructure

Drainage systems, including sustainable urban drainage systems

Knowledge of designing highways for different users.

### LO2 Assess the methods of earthwork operations, bridges and tunnelling which are used in connection with the provision of highways

#### *Earthwork operations methods:*

Accommodation of cut and fill balancing into earthwork operation

Use of ground stabilisation techniques, including lime injection and use of specialised plant for the construction of highways in areas of weak soils

Forming of embankments, including retaining walls and assessment of the soil's angle of repose to stabilise the surrounding rock or soil

Engineering control of earthwork operations

Formation testing.

*Bridges:*

Formation of abutments

Active and passive span arrangement

Bridge deck and bearing details to be used

Architectural requirements of the structures

Typical types of highway bridges used.

*Tunnel provision:*

Formation of tunnel, including considerations of cut and cover, pipe jacking, and boring, including use of tunnel boring machines

Soils conditions and proposed destination for surplus material

Maintenance arrangements

Materials used for tunnel linings.

**LO3 Justify the selection of pavement construction type for a given highway provision**

*Flexible pavement construction:*

Use of dense bitumen macadam, high-density macadam, pervious macadam, mastic asphalt and hot rolled asphalt

Properties of aggregates and uses

Common construction methods

Environmental performance, skid resistance and deterioration

Sub-base materials used and construction technique.

*Rigid pavement construction:*

Concrete mix details, reinforcement and joint details

Use of pavement trains

Environmental performance, skid resistance and deterioration

Sub-base materials used and construction technique.

**LO4 Present a report that specifies improvements that can be made to a given highway infrastructure, including maintenance techniques and planning**

*Improvement to existing highway infrastructure:*

Use and effectiveness of 'smart' motorways

Utilisation of redundant infrastructure

Provision of technology to improve public transport systems

Appraising the use and implementation of traffic management systems to prevent congestion.

*Maintenance planning and techniques:*

Knowledge of common degradation processes for highway structures

Appraising techniques for essential or routine repair to concrete supporting infrastructure

Techniques for renewing worn out pavement surfaces

Techniques for surveying road conditions for the production of repair schedules or asset management.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Evaluate how a new highway route is identified, planned and designed		<b>L01 and L02</b>  <b>D1</b> Critically analyse design details for the earthwork operations, bridges and tunnelling of a new highway
<b>P1</b> Analyse how the route of a new section of highway is identified and planned; highlighting the required legal procedures	<b>M1</b> Review a schematic design, considering the application of current practice	
<b>L02</b> Assess the methods of earthwork operations, bridges and tunnelling which are used in connection with the provision of highways		
<b>P2</b> Evaluate all the anticipated earthwork operations for a major new highway within a developed sector of a community, including difficult terrain  <b>P3</b> Prepare an outline design and method statement for the forming of a tunnel section on the proposed new highway	<b>M2</b> Discuss the interrelationship between the earthwork operations, bridges and the tunnelling of a new highway	
<b>L03</b> Justify the selection of pavement construction type for a given highway provision		<b>D2</b> Evaluate the methods and techniques for providing a flexible pavement to a new highway
<b>P4</b> Select a pavement type to be used and provide a critical analysis to justify your decision  <b>P5</b> Justify the selection of a pavement construction type	<b>M3</b> Compare flexible and rigid pavement construction for a new highway	

Pass	Merit	Distinction
<p><b>LO4</b> Present a report that specifies improvements that can be made to a given highway infrastructure, including maintenance techniques and planning</p>		
<p><b>P6</b> Present improvements to a given existing and new highway provision</p> <p><b>P7</b> Evaluate common highway faults and highlight effective maintenance regimes as preventative measures for a given project</p>	<p><b>M4</b> Discuss techniques and methods which can improve the effectiveness and conditions of the given highway project</p>	<p><b>D3</b> Critically evaluate a report on improvements to a highway infrastructure scheme, including alternative actions that could be taken</p>

## Recommended resources

### Textbooks

O'FLAHERTY, C. (2002) *Highways: The Location, Design, Construction & Maintenance of Pavements*. 4th ed. Oxford: Butterworth-Heinemann.

ROGERS, M. (2008) *Highway Engineering*. 2nd ed. Oxford: Blackwell Publishing.

WATSON, J. (1994) *Highway Construction & Maintenance*. 2nd ed. Harlow: Longman.

### Websites

[www.highways.gov.uk](http://www.highways.gov.uk)

Highways England  
(General Reference)

[www.theihe.org](http://www.theihe.org)

The Institute of Highways Engineers  
(General Reference)

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 8: Mathematics for Construction*

*Unit 14: Building Information Modelling*

*Unit 18: Civil Engineering Technology*

*Unit 25: Management for Complex Building Projects*

*Unit 27: Construction Technology for Complex Building Projects*

*Unit 28: Further Mathematics for Construction*

*Unit 29: Geotechnics & Soil Mechanics*

*Unit 30: Advanced Structural Design*

*Unit 36: Advanced Building Information Modelling*

*Unit 43: Hydraulics*

# Unit 43: Hydraulics

<b>Unit code</b>	<b>M/615/1428</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The action, management and distribution of fluids, in relation to built structures, is critical. In civil engineering, it is necessary to ensure that we are able to manage the pressures that water may put on structures, either through its flow or the forces exerted and how to resist these. In building services, the balance between necessary pressures to ensure flow and distribution of fluids (through heating/cooling systems or domestic water supplies), and the sizing of pipes to support this flow, will determine efficiency and effectiveness of a system.

However, fluids are dynamic; their behaviour changes based on a range of factors. Thus, the ability to estimate and manage their forces, rates of flow and suitable systems for control requires specialised calculations, equipment and maintenance.

Through this unit students will explore principles of hydrostatic and hydrodynamic fluids, calculate a range of factors and use these calculations to arrive at practical hydraulic solutions.



## Learning Outcomes

By the end of this unit, students will be able to:

- 1 Apply concepts of physics to develop solutions for hydrostatic and hydrodynamic problems
- 2 Calculate forces related to fluids at rest and in motion
- 3 Develop practical solutions for the distribution of fluids within correctly sized pipes
- 4 Calculate the hydrostatic pressure exerted on substructures for a given context.

## Essential Content

### LO1 **Apply concepts of physics to develop solutions for hydrostatic and hydrodynamic problems**

*Fluid properties:*

Density

Viscosity.

*Fluid behaviour:*

Viscous flow

Laminar flow

Turbulence

Boundary layer.

### LO2 **Calculate forces related to fluids at rest and in motion**

*Flow calculation:*

Bernoulli's equation

Hydraulic radius

Velocity distribution

Reynolds number.

*Energy:*

The energy principle

The energy equation

Hydraulic grade

Energy grade

Energy loss/gain

Friction losses.

**LO3 Develop practical solutions for the distribution of fluids within correctly sized pipes**

*Flow in pipes:*

Darcy-Weisback equation

Chezy's equation (Kutter's equation)

Discharge

Head loss

Pipeline discharge

Orifice equation.

*Open channel flow:*

Steady/uniform flow

Manning's equation

Specific energy/critical depth

Subcritical/supercritical flow

Non-uniform flow.

**LO4 Calculate the hydrostatic pressure exerted on substructures for a given context**

*Hydrostatic pressure:*

Forces on plane

Forces on submerged surfaces

Pascal's law.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems		<b>LO1. LO2 and LO3</b>  <b>D1</b> Assess pipework sizes to determine their efficiency in a given context
<b>P1</b> Evaluate a hydraulic condition in order to determine the parameters of the problem  <b>P2</b> Illustrate a proposed solution to a hydraulic problem, using drawings or models	<b>M1</b> Compare proposed solutions to a hydraulics problem, highlighting the merits of different solutions	
<b>LO2</b> Calculate forces related to fluids at rest and in motion		
<b>P3</b> Solve a Darcy-Weisback equation for a given pressure pipe system  <b>P4</b> Solve a Manning's equation for given open channel flow situation	<b>M2</b> Discuss the differences and similarities between different types of hydrodynamic systems and calculations	
<b>LO3</b> Develop practical solutions for the distribution of fluids within correctly sized pipes		
<b>P5</b> Calculate the head loss for a given pipeline  <b>P6</b> Define pipe sizes for a given set of flow parameters	<b>M3</b> Evaluate pipe sizes to determine the flow type that will occur	
<b>LO4</b> Calculate the hydrostatic pressure exerted on substructures for a given context		<b>D2</b> Present proposals for subsurface structures in response to the hydrostatic pressure of a given context
<b>P7</b> Calculate the pressure exerted on a foundation wall in a given context  <b>P8</b> Calculate the pressure exerted on a subsurface floor in a given context	<b>M4</b> Evaluate the ability of a given subsurface wall and floor to resist the forces exerted by liquid in a given context	

## Recommended resources

### Textbooks

DOUGLAS, J.F. (2011) *Fluid Mechanics*. London: Prentice Hall.

HALL, F. and GREENO, R. (2015) *Building Services Handbook*. London: Routledge.

MASSEY, B.S., BERNARD S, and WARD-SMITH, A.J. (2012) *Mechanics of Fluids*. London: Spon Press.

STROUD, K.A. and BOOTH, D.J. (2013) *Engineering Mathematics*. London: Palgrave Macmillan.

WYNN, P. (2014) *Hydraulics for Civil Engineers*. London: ICE Publishing.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 17: Principles of Public Health Engineering*

*Unit 18: Civil Engineering Technology*

*Unit 27: Construction Technology for Complex Building Projects*

*Unit 28: Further Mathematics for Construction*

*Unit 29: Geotechnics & Soil Mechanics*

*Unit 30: Advanced Structural Design*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 42: Highway Engineering*

## Unit 44: Advanced Surveying & Measurement

<b>Unit code</b>	<b>T/615/1429</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

As technology advances it provides a means to enhance and improve the services that setting-out and surveying can provide to the construction industry. As the built environment increases in complexity, there is a need to apply systems and skills to ensure that structures are accurately controlled in their setting-out and construction.

This unit explores the techniques used to assess the accuracy of GPS co-ordinates, the creation and use of a control network, and it also explores transfer points and the use of software and technology.

On successful completion of this unit students will be able to set up and assess the accuracy of GPS co-ordinates. From this principle they will be able to create and use a control network. The student will be able to describe the procedures for transferring control points up a multi-storey structure. The student will be able analyse errors in setting out and surveying.

## Learning Outcomes

By the end of this unit, students will be able to:

- 1 Conduct a traverse survey on GPS obtained co-ordinates including corrections
- 2 Produce a full topographic survey; identifying landscape features, heights and positions of existing structures, for a given site
- 3 Evaluate industry standard techniques in transferring control points up a multi-storey structure
- 4 Prepare a report on the benefits of software applications and emerging technology used in surveying and Setting-out.

## Essential Content

### LO1 **Conduct a traverse survey on GPS obtained co-ordinates including corrections**

*Global Positioning System:*

Methods of working

Available systems

Accuracy achievable.

*Conducting a survey of the Global Positioning System obtained stations:*

Carrying out a full survey of tie distances and height differences

Adjustment of stations by creating a master station

Calculations to obtain corrected co-ordinates and use of free station function to check.

### LO2 **Produce a full topographic survey; identifying landscape features, heights and positions of existing structures, for a given site**

*Create a control network:*

Location of control points

Use of the total station surveying mode to obtain co-ordinates

Calculation of station heights.

*Use of the network to produce a full topographic survey:*

Use of free station to complete the survey

Coding systems for features to be surveyed

Production of a full topographic survey.



### **LO3 Evaluate industry standard techniques in transferring control points up a multi-storey structure**

#### *Examples of construction elements:*

Building outlines, centre lines of structural elements, boundary locations from national co-ordinates, road centre lines, drainage and hard landscape features.

#### *Setting-out techniques:*

Holistic view of setting-out for the whole to the part

Use of free station, reference lines, stake out, tie distances within a total station program

Techniques to obtain Setting-out data including data transfer

Process of Setting-out structures & offsetting lines of structural elements

Horizontal & vertical control of construction both initially and as the work commences.

### **LO4 Prepare a report on the benefits of software applications and emerging technology used in surveying and Setting-out**

#### *Errors in surveying and Setting-out:*

Instrumentation error: Prism constants, Reflector heights, atmospheric influences, calibration certification, free station errors, discrete Setting-out

Human errors: Alignment of levelling staffs & hand or tripod mounted prisms, physical Setting-out constraints.

#### *Improvement of accuracy:*

Use of technology to provide checking methods

Testing procedures for instrumentation to be used in Setting-out and surveying

Comparing accuracy of set out element to nationally recognised standards.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Conduct a traverse survey on GPS obtained co-ordinates including corrections		<b>LO1 and LO2</b> <b>D1</b> Critically analyse the accuracy achieved in a station network using GPS data and total station networks for a topographic survey
<b>P1</b> Conduct a closed traverse survey using GPS data <b>P2</b> Discuss the use of GPS technology in establishing station points and the potential error sources in GPS data <b>P3</b> Use differential correction techniques to adjust GPS survey data, as necessary	<b>M1</b> Evaluate the accuracy of GPS survey data in relation to traditional methods of surveying	
<b>LO2</b> Produce a full topographic survey, identifying landscape features, heights and positions of existing structures, for a given site		
<b>P4</b> Define a control network to complete a full topographic survey <b>P5</b> Produce survey drawings; with contours, features and structures shown using industry standard notation	<b>M2</b> Asses the potential for instrument error in defining a complex control network	
<b>LO3</b> Evaluate industry standard techniques in transferring control points up a multi-storey structure		<b>D2</b> Critically evaluate the potential errors that may arise in transferring control points
<b>P6</b> Extract and transfer the required data from a given project to a total station in order to allow Setting-out to commence <b>P7</b> Complete a full Setting-out operation on a given project by utilising a total station <i>free station</i> programme; including both horizontal and vertical control	<b>M3</b> Analyse the accuracy achieved from a Setting-out operation from tie distances recorded, total station stored data and other means	

Pass	Merit	Distinction
<p><b>LO4</b> Prepare a report on the benefits of software applications and emerging technology used in surveying and Setting-out</p>		<p><b>D3</b> Justify the selection of digital surveying tools; based on their accuracy and ability to provide suitable data</p>
<p><b>P8</b> Discuss digital tools available for use in surveying and Setting-out</p> <p><b>P9</b> Assess the benefits of digital tools in surveying and Setting-out</p>	<p><b>M4</b> Select appropriate digital tools to use for a given survey requirement</p>	

## Recommended resources

### Textbooks

IRVINE, W. and MACLENNAN, F. (2005) *Surveying for Construction*. 5th ed. London: McGraw-Hill.

SCHOFIELD, W. and BREACH, M. (2007) *Engineering Surveying*. 6th ed. Oxford: Elsevier.

SADGROVE, B.M. (2007) *Setting-out Procedures for the Modern Built Environment*. London: Ciria.

UREN, J. and PRICE, W. (2010) *Surveying for Engineers*. 5th ed. Basingstoke: Palgrave Macmillan.

### Websites

[www.ice.org.uk](http://www.ice.org.uk)

Institution of Civil Engineers  
(General Reference)

### Links

This unit links to the following related units:

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 11: Measurement & Estimating*

*Unit 13: Tender & Procurement*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 30: Advanced Structural Design*

*Unit 36: Advanced Building Information Modelling*

*Unit 42: Highway Engineering*

# Unit 45: Maintenance & Operations

<b>Unit code</b>	<b>K/615/1430</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The aim of this unit is to provide students with background knowledge and understanding of maintenance and operations required in relation to the safe and efficient use of buildings; within both specific contexts and the wider environment.

Students will examine the different maintenance elements and materials available, the varied approaches to managing the processes of maintenance, the impact of planning and scheduling, how maintenance operations integrate with the wider environment and how these impact on core business activities.

Students will explore the relationship of maintenance and operations as an integral part of the building lifecycle ('from cradle to grave') and how the wider external business environment impacts on the way in which maintenance and operations are managed.

On successful completion of this unit students will have the knowledge to be able to make informed decisions as to how to manage the maintenance of a building from design stage through construction phase and into the stage of facilities management; taking into consideration the Health & Safety of the building and its occupants at all stages of the lifecycle.

## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Discuss the different industry sectors involved in maintenance, specific material elements and materials used in the maintenance of buildings
- 2 Compare the different types of maintenance management available and how they interrelate
- 3 Demonstrate how Building Information Modelling assists in managing maintenance and operations effectively and efficiently
- 4 Assess how maintenance and operations are managed as part of a wider business management strategy.

## Essential content

### LO1 **Discuss the different industry sectors involved in maintenance, specific material elements and materials used in the maintenance of buildings**

*Different types of industry sectors involved in maintenance:*

Designers: planners, project managers, architects, surveyors

Building trades: joiners, plasterers, decorators, plumbers

Mechanical and electrical engineers: water, gas, electric and green energy

Facilities management

Other parties: client, contractor, tenant, leaseholder.

*Specific material elements and materials used in the maintenance of buildings:*

The range of structural and material elements within a building that may require maintenance

The range of hard and soft services within a building that may require maintenance

The statutory legal requirements for undertaking maintenance

The frequency of maintenance being undertaken in regard to the actual building element/material being used during its expected lifecycle.

### LO2 **Compare the different types of maintenance management available and how they interrelate**

*Types of maintenance management available:*

Reactive maintenance

Planned maintenance

Cyclical maintenance

Routine maintenance

Proactive maintenance.

*How types of maintenance management interrelate:*

Reactive v planned maintenance

Design stage (BIM): proactive maintenance

Cyclical and routine maintenance

Core business: budgetary considerations overall

Weaknesses and strengths.

**LO3 Demonstrate how Building Information Modelling assists in managing maintenance and operations effectively and efficiently**

*Models for planning:*

SWOT analysis

Action plans

Scheduling

Financial constraints (revenue and capital)

Building Information Modelling for asset management and maintenance.

*Sustainable maintenance:*

Finance and management of budgets

Resources (hard and soft)

Health & safety compliance and best practice

Introduction to lifecycle management for maintenance.

**LO4 Assess how maintenance and operations are managed as part of a wider business management strategy**

*Core business management:*

Impact of core business and maintenance operations on one another

Impact of expected lifecycle of core business on maintenance management.

*Facilities management:*

Contract parameters for hard/soft facilities management

Integrating management systems together to ensure efficiency and sustainability are achievable.



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Discuss the different industry sectors involved in maintenance, specific material elements and materials used in the maintenance of buildings</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Critically analyse how maintenance may be undertaken over a period of time whilst ensuring compliance with statutory regulations and legislation</p>
<p><b>P1</b> Discuss the different sectors in industry that contribute directly and indirectly to the maintenance of buildings and infrastructure</p> <p><b>P2</b> Discuss the different material elements that are commonly used in building maintenance</p> <p><b>P3</b> Assess the primary factors that need to be considered in relation to Health &amp; Safety, sustainability and the environment when undertaking general building maintenance works</p>	<p><b>M1</b> Evaluate the relationship between building maintenance and building operating costs</p>	
<p><b>LO2</b> Compare the different types of maintenance management available and how they interrelate</p>		
<p><b>P4</b> Discuss management approaches to undertaking maintenance</p> <p><b>P5</b> Illustrate how maintenance of a building or infrastructure can be undertaken through the interrelation of more than one maintenance management type</p>	<p><b>M2</b> Evaluate the advantages and disadvantages of each of the maintenance management approaches</p>	

Pass	Merit	Distinction
<p><b>LO3</b> Demonstrate how Building Information Modelling assists in managing maintenance and operations effectively and efficiently</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Critically evaluate the role of Building Information Modelling in supporting sustainable practice in maintenance and operations, relating this to broader business practices and strategies</p>
<p><b>P6</b> Review the financial considerations that are required to be addressed when developing maintenance and operations programmes</p> <p><b>P7</b> Discuss the role of Building Information Modelling in managing built assets throughout their lifecycle</p>	<p><b>M3</b> Explore the benefits and constraints of using a model for planning maintenance and operations programmes</p>	
<p><b>LO4</b> Assess how maintenance and operations are managed as part of a wider business management strategy</p>		
<p><b>P8</b> Discuss the impacts of core business and facilities/maintenance management on one another, on a day-to-day basis</p> <p><b>P9</b> Assess the areas of maintenance that are managed as part of an operational management structure and acknowledge the statutory legislation that requires formal compliance</p>	<p><b>M4</b> Reflect on the contract parameters for facilities management and explain the implications on core business, in relation to maintenance and operational management requirements</p>	

## Recommended resources

### Textbooks

ATKIN, B. and BROOKS, A. *Total Facility Management*. 4th ed. London: Wiley-Blackwell.

BOOTY, F. (2009) *Facilities Management Handbook*. London: Butterworth-Heinemann.

CHANTER, B. and SWALLOW, P. (2007) *Building Maintenance Management*. Chichester, West Sussex: Blackwell.

HALL, F. and GREENO, R. (2015) *Building Services Handbook*. London: Routledge.

KLEMISCH, J. (2011) *Maintenance of Historic Buildings: A Practical Handbook*. London: Donhead Publishing Ltd.

WOOD, B. (2009) *Building Maintenance*. Chichester, West Sussex: Wiley-Blackwell.

WIGGINS, J.M. *Facilities Manager's Desk Reference*. Chichester, West Sussex: Wiley-Blackwell.

### Websites

<a href="http://www.bifm.org.uk">www.bifm.org.uk</a>	British Institute of Facilities Management (General Reference)
<a href="http://www.facilities-manager.co.uk">www.facilities-manager.co.uk</a>	Facilities Manager Magazine (General Reference)
<a href="http://www.building.co.uk">www.building.co.uk</a>	Building Magazine Online (Articles)
<a href="http://www.bdonline.co.uk">www.bdonline.co.uk</a>	Building Design (Articles)

## **Links**

This unit links to the following related units:

*Unit 3: Science & Materials*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 12: Financial Management & Business Practices in Construction*

*Unit 14: Building Information Modelling*

*Unit 23: Contracts & Management*

*Unit 24: Project Management*

*Unit 25: Management for Complex Building Projects*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 32: Building Management Systems*

*Unit 36: Advanced Building Information Modelling*

*Unit 47: Construction Data Management*

## Unit 46: Advanced Materials

<b>Unit code</b>	<b>M/615/1431</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

Technological advancements have allowed us to develop material composites with optimum strength performance. Advanced composites allow lightweight materials to perform like metal components, with the necessary strength and stability. 'Smart' materials, that can alter their properties in response to external stimuli, are increasingly being found in ever more innovative design solutions. This progress in material technology and processing techniques is essential for the efficient delivery of contemporary buildings and infrastructure.

The aim of this unit is to enable students to make decisions based on the application of knowledge and concepts related to advanced materials. As ever more innovative structural solutions are sought, so the need for greater understanding of material performance and behaviour is required. This encapsulates an understanding of the relationship between material microstructure, composition and mechanical properties in use, and also a knowledge of 'smart' materials that are at the heart of innovative material technology development.

Upon successful completion of this unit students will be able to make decisions based on an analytical approach to understanding material performance. They will also be able to make an appraisal about the feasibility of innovative and smart materials in construction projects.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Evaluate the characteristic properties which contribute to the mechanical functionality of materials
- 2 Examine failure mechanisms of different materials through intrinsic and extrinsic methods
- 3 Present a case study exploring innovative and smart materials and their role in sustainable construction
- 4 Analyse material selection and design strategies in either a structural or civil engineering environment.

## Essential Content

### LO1 Evaluate the characteristic properties which contribute to the mechanical functionality of materials

#### *Properties of materials:*

Drivers for material characterisation and testing

Relationship of microstructure and manufacture/processing to the properties

Mechanical properties and deformation of materials.

#### *Underpinning principles of materials characterisation:*

Destructive and non-destructive testing

Characterisation testing techniques, equipment, and practices of material characterisation methods; microscopy, chemical, physical and structural analysis, and thermal techniques

Competencies and limitations of testing methods in determining functional properties of materials.

#### *Material processing techniques:*

Processing techniques: heat treatment, coating processes, surface treatments

Manufacturing techniques.

### LO2 Examine failure mechanisms of different materials through intrinsic and extrinsic methods

#### *Modes of failure:*

Deflection, fatigue, creep, distortion, corrosion, fracture, impact, thermal cycling etc., including combinations.

#### *Extrinsic failure (environmental):*

Environmental interactions and factors leading to the failure of materials.

#### *Intrinsic failure (material):*

Crystallography and fracture mechanics

Design faults, assembly error, material defects.

*Failure prevention mechanisms:*

Practices and techniques used to prevent or impede environmentally induced failure of materials; materials selection, engineering design and materials monitoring and inspection strategies.

**LO3 Present a case study exploring innovative and smart materials and their role in sustainable construction**

*Innovative and smart materials:*

Composite materials: matrix composition, glass reinforced plastic (GRP), fibre-reinforced polymers (FRP), concretes, metals

Innovative materials: aerogels, smart concrete, aluminium oxynitride glass (ALON)

Nanotechnology: photocatalytic concrete, nano-silica, carbon nanofibers, nano-calcite particles

Reversible energy exchanging, energy exchanging, property changing materials

Smart materials and sustainability.

*Use of innovation and smart materials:*

Creation of energy efficient structures

Adaptive and intelligent behaviours as characterisation properties.

**LO4 Analyse material selection and design strategies in either a structural or civil engineering environment**

*Design intent:*

Design for strength

Design for failure avoidance

Design for energy efficiency.



## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Evaluate the characteristic properties which contribute to the mechanical functionality of materials</p>		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Evaluate data from material characterisation techniques and discuss how this information may inform material selection choices</p>
<p><b>P1</b> Discuss material characterisation methods for a selection of vocationally relevant materials</p> <p><b>P2</b> Determine the properties and characteristics of materials based on data from testing</p> <p><b>P3</b> Evaluate how material characteristics are influenced by the forms in which materials are commonly available</p>	<p><b>M1</b> Describe the effects of different manufacturing methods in relation to material properties</p>	
<p><b>LO2</b> Examine failure mechanisms of different materials through intrinsic and extrinsic methods</p>		
<p><b>P4</b> Explore cause and effect of intrinsic and extrinsic modes of failure</p> <p><b>P5</b> Select materials and processing methods for a given structural element</p>	<p><b>M2</b> Discuss methods of remedial or preventative action to enhance service life of a range of materials</p>	

Pass	Merit	Distinction
<b>L03</b> Present a case study exploring innovative and smart materials and their role in sustainable construction	<b>M3</b> Describe typical applications of smart materials with reference to their characteristics and properties	<b>D2</b> Using a given structural element or characteristic of traditional manufacture, analyse how a smart or innovative material could replace it
<b>P6</b> Evaluate key performance features of smart materials <b>P7</b> Produce a case study discussing the use of innovative materials currently available or in use in the construction industry		
<b>L04</b> Analyse material selection and design strategies in either a structural or civil engineering environment	<b>M4</b> Justify the selection of construction materials by exploring the benefits gained from specific production processes or techniques for their intended end use	<b>D3</b> Assess the use of advanced materials or techniques to prevent structural failure and create energy efficient structures
<b>P8</b> Analyse a selection of suitable materials for a given design problem or structural element		

## Recommended resources

### Textbooks

AHMED, A. and STURGES, J. (2014) *Materials Science in Construction: An Introduction*. Abingdon: Routledge.

ASHCROFT, N. and DAVID, M. (2003) *Solid State Physics*. Faridabad: Thomson Press Ltd.

BORESI, A. and SCHMIDT, R. (2002) *Advanced Mechanics of Materials*. 6th ed. John Wiley & Sons.

CASINI, M. (2016) *Smart Buildings: Advanced Materials and Nanotechnology to Improve Energy-Efficiency and Environmental Performance*. Kidlington: Woodhead Publishing Ltd.

CLAISSE, P.A. (2015) *Civil Engineering Materials*. Kidlington: Butterworth-Heinemann.

COOK, R. and YOUNG, W. (1994) *Advanced Mechanics of Materials*. 2nd ed. Pearson Education.

DOMONE, P. and ILLSTON, J. (2010) *Construction Materials*. Abingdon: Routledge.

IBACH, H. (2009) *Solid-State Physics: An Introduction to Principles of Materials Science*. Berlin: Springer.

MOSKOWITZ, S. (2016) *Advanced Materials Innovation: Managing Global Technology in the 21st Century*. Chichester, West Sussex: Wiley-Blackwell.

SJOSTROM, C. (2006) *Durability of Building Materials and Components 7: Proceedings of the Seventh International Conference*. Abingdon: Taylor & Francis.

### Links

This unit links to the following related units:

*Unit 2: Construction Technology*

*Unit 3: Science & Materials*

*Unit 15: Principles of Refurbishment*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 30: Advanced Structural Design*

*Unit 45: Maintenance & Operations*

# Unit 47: Construction Data Management

<b>Unit code</b>	<b>T/615/1432</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

A tremendous amount of information is shared, stored, managed and created as part of a complex construction project. It is for this reason that data management forms a critical component to the future of the construction industry. The skills required to be able to effectively manage and review this information intelligently are equally critical. This unit will draw upon the main concepts surrounding Building Information Management (BIM) and further explore the importance of information management.

This unit will detail the processes required to effectively communicate the information required by the client, or asset owner, and how to ensure data is managed throughout a project with the relevant skills and requirements necessary to avoid duplication, error or missing information.

The knowledge, skills and understanding of the importance of data within a BIM-enabled project is critical for the success of the project and students will begin to explore ways in which this process is managed intelligently and supported across a project lifecycle.

## Learning Outcomes

By the end of this unit, students will be able to:

- 1 Assess the importance of information management within the construction industry
- 2 Evaluate the role of information management and how it can benefit and support intelligent information exchanges
- 3 Illustrate the information delivery cycle, in regard to BIM, and how the information management process aids the design, construction and occupation of an asset
- 4 Discuss the ways in which information can be captured, shared and managed throughout a project lifecycle.

## Essential Content

### LO1 **Assess the importance of information management within the construction industry**

*The relevance of information management and how it can aid in the construction process*

*The importance of managing information during the design, construction and operation phases of an asset*

*Tools and processes to effectively manage information across a project lifecycle*

*Technology that supports effective information management*

*Post-occupancy evaluation and managing the information once a built asset is in use*

*The basic principles of 'Soft Landings' and how this can be applied at the very early stages of a project*

### LO2 **Evaluate the role of information management and how it can benefit and support intelligent information exchanges**

*A thorough evaluation of the definition of information management*

*The importance of the role of information management in regard to BIM*

*Tasks that must be undertaken to ensure effective information management and exchange*

*Roles and responsibilities that support information management*

*Supporting and collating information across all stages of a project*

*Information management and collaborative working*

*Client roles and responsibilities*

*Information exchange formats*

*Monitoring progress*

**LO3 Illustrate the information delivery cycle, in regard to BIM, and how the information management process aids the design, construction and occupation of an asset**

*The requirements of information delivery across all stages*

*Data drops and a plan of work*

*Formats, schedules, and information exchanges*

*The importance of 'Plain Language Questions'*

*The employer's information requirements (EIR) and defining information deliverables*

*Supplier assessment and capability, and ways in which this can be achieved*

*Pre-qualification and BIM*

*Tendering on a BIM project*

*The pre- vs post-contract BIM Execution Plan; information requirements*

*Supplier responsibilities and the delivery of the individual discipline information*

*Task team information plans (TIDPs)*

*The master information delivery plan (MIDP)*

*Collating the data at handover*

**LO4 Discuss the ways in which information can be captured, shared and managed throughout a project lifecycle**

*Defining information exchange deliverables against an LOD matrix, or design responsibility matrix*

*Federation of geometric and non-geometric data, the key differences*

*The importance of consistent exchange formats to federate project information*

*The Common Data Environment (CDE) and sharing, archiving and storing data*

*Storing data post-occupation*

*Security and managing the built asset information*

*The asset information model and updating information during the occupation of an asset*

*Information exchange formats and examples of these*

*Defining data drops at key decision points.*

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Assess the importance of information management within the construction industry		<b>LO1 and LO2</b>  <b>D1</b> Critically evaluate the way that information exchange formats, deliverables and processes benefit stakeholders by increasing the accuracy of information
<b>P1</b> Assess how information should be intelligently managed across a project  <b>P2</b> Discuss the importance of information management and how it relates to the BIM process	<b>M1</b> Review information management techniques that can positively affect a building or infrastructure project  <b>M2</b> Evaluate the tools available to effectively manage information across an asset portfolio	
<b>LO2</b> Evaluate the role of information management and how it can benefit and support intelligent information exchanges		
<b>P3</b> Evaluate the role of information management and the key requirements of this role in regard to a building project  <b>P4</b> Evaluate how information management is supported by the key concepts relating to collaborative working	<b>M3</b> Review the responsibilities of an assigned 'information manager' for a project and how these responsibilities differ from the roles that are traditionally appointed on a project	



Pass	Merit	Distinction
<p><b>LO3</b> Illustrate the information delivery cycle in, regard to BIM, and how the information management process aids the design, construction and occupation of an asset</p>		<p><b>LO3 and LO4</b></p> <p><b>D2</b> Evaluate the differences between the current forms of a Common Data Environment (CDE) and create an implementation plan on behalf of an owner</p>
<p><b>P5</b> Discuss how the information delivery cycle can aid and support a project across all stages</p> <p><b>P6</b> Illustrate how information is shared and managed in line with an information delivery cycle</p>	<p><b>M4</b> Review how information will be transferred across a project during the design and construction stage and into the asset management stage</p>	
<p><b>LO4</b> Discuss the ways in which information can be captured, shared and managed throughout a project lifecycle</p>		
<p><b>P7</b> Assess ways in which information can be captured from a variety of sources, including BIM authoring tools</p> <p><b>P8</b> Discuss the information deliverables that may be relevant to an asset</p>	<p><b>M5</b> Analyse ways in which information can be collated and 'checked' on behalf of an asset owner to ensure asset information and information deliverables have been captured by suppliers</p>	

## Recommended resources

### Textbooks

EASTMEN, C., TEICHOLZ, P., SACKS, R. and LISTON, K. (2011) *BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors*. 2nd ed. John Wiley & Sons Inc.

FAIRHEAD, R. (2013) *Information Exchanges: RIBA Plan of Work 2013 Guide*. London: RIBA Publishing.

HOLZER, D. (2016) *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering and Construction*. Chichester, West Sussex: John Wiley & Sons Inc.

MORDUE, S., PHILP, D. and SWADDLE, P. (2015) *Building Information Modelling for Dummies*. Chichester, West Sussex: John Wiley & Sons Inc.

SAXON, R. (2016) *BIM for Construction Clients*. London: RIBA Publishing.

SHEPHERD, D. (2015) *BIM Management Handbook*. London: RIBA Publishing.

### Websites

<a href="http://www.theb1m.com">www.theb1m.com</a>	The B1M (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group (General Reference)
<a href="http://www.bimtaskgroup.org">www.bimtaskgroup.org</a>	The BIM Task Group 'COBie UK 2012' (General Reference)
<a href="http://www.thenbs.com">www.thenbs.com</a>	NBS 'BIM (Building Information Modelling)' (General Reference)

## **Links**

This unit links to the following related units:

*Unit 4: Construction Practice & Management*

*Unit 5: Legal & Statutory Responsibilities in Construction*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 13: Tender & Procurement*

*Unit 14: Building Information Modelling*

*Unit 23: Contracts & Management*

*Unit 24: Project Management*

*Unit 26: Advanced Construction Drawing & Detailing*

*Unit 36: Advanced Building Information Modelling*

*Unit 45: Maintenance & Operations*

## Unit 48: Scientific Principles for Building Services

<b>Unit code</b>	<b>H/617/0929</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

### Introduction

Building services engineering is based upon the application of scientific principles, requiring an understanding of key mathematical formulas. Through this unit students will develop an understanding of the scientific principles and mathematical concepts necessary to design and specify building services plant and equipment. Covering areas such as heat transfer, fluid flow, acoustics electrical networks and control systems, students will consider the way that scientific principles underpin our understanding of the relationship between building services and human comfort.

By the end of this unit students will have a grounding in the application of scientific principles in relation to the design and specification of building services, and the understanding of how these services are employed to support human activity with buildings.

## **Learning Outcomes**

By the end of this unit, students will be able to:

- 1 Calculate energy transfer rates in different building services contexts
- 2 Evaluate conditions of fluid flow to determine energy loss
- 3 Design electrical circuits for single-phase AC networks
- 4 Determine the effects of sound and vibration related to building services and human comfort.

## Essential Content

### LO1 Calculate energy transfer rates in different building services contexts

#### *Heat transfer:*

Conduction

One-dimensional

Convection

Radiation

Black body

Grey body

Evaporation

Stefan's Constant

Insulated surfaces

Insulation and cost

Condensation risk

Surface

Interstitial

Temperature gradients.

#### *Thermal comfort:*

Physiological factors

Psychological factors

Thermal indices

Predicting thermal comfort

Assessing thermal comfort

Reliability of design criteria.

*Calculations:*

Heat transfer rates through structure

Composite structures, pipes & ducts

Complex structures

Thermally bridged structures

Thermal conductivity

Heat transfer coefficients

Heat conduction rates

Using star thermal resistance networks

Using delta thermal resistance networks.

**LO2 Evaluate conditions of static and dynamic fluid flow to determine energy loss**

*Fluid flow*

Parameters:

Pressure

Velocity

Density

Mass & volume

Flowrate

Viscosity

Temperature

Laminar flow

Turbulent flow

Boundary separation and transition

Reynolds number

Moody Charts

Uniform and steady flow

Continuity of flow

Conservation of energy

Bernoulli's equation

Volume and mass transfer

Measurement of fluid flow rates

Venturi meter

Orifice plate

Pitot-static tubes.

*Energy losses*

Frictional losses

In pipe networks

In duct networks

Frictional coefficients

Zeta factors

Velocity pressure factors

Static regain in expansion equipment

Gravitational flow in flooded and partially flooded conduits

Guttering, channels, drainage pipes and soil/waste stacks

Formulae

Manning

Reynolds number

Crimp and Bruges

Darcy-Weisback

Chezy.



### LO3 **Design electrical circuits for single-phase AC networks**

#### *Non-resonant circuits*

Series

Parallel and complex networks

Resistance

Capacitance

Inductance

Reactance and impedance

Potential difference

Current flow in non-resonant circuits and single-phase AC circuits

Power factor

True, reactive and apparent power

Heating and magnetic effects of electric currents.

#### *Resonant circuits*

Definition of circuit resonance

Circuit conditions at resonance

Coil and capacitor in series or parallel

Resonant frequency

Dynamic frequency

#### *Power factor correction*

Capacitance to improve power factor of an inductive load

Benefits of power factor correction.

**LO4 Determine the effects of sound and vibration related to building services and human comfort**

*Effects of sound and vibration*

Transmission and propagation of sound

Measurement of sound

Room acoustics.

*Transmission and propagation of sound*

Sound power

Frequency spectra

External sources

Internal source

Propagation of acoustic energy

Sound insulation

Sound attenuation.

*Measurement of sound*

Decibel scales

Equivalent continuous noise levels

Sound power levels (SPL)

Sound intensity levels (SIL)

Sound power produced by building services installations.

*Room acoustics*

Background and total sound levels

Reverberation time

Sound absorption

Anti-vibration mountings.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Calculate energy transfer rates in different building services contexts		<b>D1</b> Critically evaluate the efficiency of different forms of heat transfer for a given range of heat emitters, plant and equipment
<p><b>P1</b> Determine heat transfer through different forms of composite structure</p> <p><b>P2</b> Determine the risk of interstitial condensation in multi-leaf plane structures</p> <p><b>P3</b> Calculate conduction rates used in various building services plant and equipment</p>	<p><b>M1</b> Evaluate the impact of heat transfer on thermal comfort and efficiency of building services plant and equipment</p>	
<b>L02</b> Evaluate conditions of fluid flow to determine energy loss		
<p><b>P4</b> Discuss the types of fluid flow, fluid energy and the potential mechanisms of energy loss</p> <p><b>P5</b> Calculate the energy loss in pipe and duct networks, using appropriate formulae</p>	<p><b>M2</b> Analyse the relationship between frictional energy loss under different gravitational flow conditions</p>	<b>D2</b> Critically evaluate fluid flow and energy principles in relation to their application in the design and control of building services engineering
<b>L03</b> Design electrical circuits for single-phase AC networks		
<p><b>P6</b> Discuss the difference between resonant and non-resonant circuits</p> <p><b>P7</b> Design resonant and non-resonant circuits, for single-phase AC networks; calculating current flow</p>	<p><b>M3</b> Compare the effect of varying resistance, capacitance and inductance in parallel and series AC circuits on voltage, resistance and impedance</p>	<b>D3</b> Analyse the methods to improve the power factor of a given circuit

Pass	Merit	Distinction
<p><b>LO4</b> Determine the effects of sound and vibration related to building services and human comfort</p>		
<p><b>P8</b> Explain the principles of sound and vibration on room acoustics and their impact on human hearing</p> <p><b>P9</b> Determine the transmission paths of sound, from building services systems, through different forms of structure</p>	<p><b>M4</b> Assess the potential reduction of sound transmission through insulation and attenuation strategies, based on comparison of results of appropriate calculations</p>	

## Recommended resources

### Textbooks

- CHADDERTON, D.V. (2012) *Building Services Engineering*. 6th ed. Abingdon, Oxon: Routledge.
- GREENO, R. (1997) *Building Services Technology & Design*. Abingdon, Oxon: Routledge.
- HALL, F.F. and GREENO, R. (2017) *Building Services Handbook*. 9th ed. Abingdon, Oxon: Routledge.
- HORSLEY, M. and KEITH, S. (1996) *Thermofluids*. London: CRC Press.
- MCMULLAN, R. (2012) *Environmental Science in Building*. 7th ed. Basingstoke, Hampshire: Palgrave Macmillan.
- MOSS, K.J. (2007) *Heat and Mass Transfer in Buildings*. 2nd ed. Abingdon, Oxon: Routledge.
- OUGHTON, D. and WILSON, A. (2015) *Faber & Kell's Heating & Air Conditioning of Buildings*. 11th ed. Abingdon, Oxon: Routledge.

### Websites

- |  |   |
|--|---|
| <a href="http://www.cibse.org">www.cibse.org</a>                           | Chartered Institute of Building Services Engineers<br>(General Reference)     |
| <a href="http://www.bsria.co.uk">www.bsria.co.uk</a>                       | Building Services Research and Information Association<br>(General Reference) |
| <a href="http://www.engineeringtoolbox.com">www.engineeringtoolbox.com</a> | The Engineering Toolbox<br>(General Reference)                                |

# Unit 49: Thermofluids and Acoustics

<b>Unit code</b>	<b>Y/617/0930</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

## Introduction

The study of thermofluids is critical to the design, specification and operation of building services engineering systems. Through this unit students will explore the key features of thermofluids; heat transfer, thermodynamics, fluid mechanics and combustion, their calculation and application. An understanding of how to calculate and manage heat transfer will provide students with key knowledge to enable their work on a range of different systems for heating and refrigeration.

In addition, students will develop an understanding of the issues associated with acoustics and the operation of building services systems. They will explore the causes of noise and vibration, how to calculate noise levels and develop strategies to manage the acoustic environment.

By the end of this unit, students will have an advanced knowledge of the formulae required to undertake calculations related to thermofluids and acoustics, applying the results to the design and specification of equipment, plant and environments.

## **Learning Outcomes**

By the end of this unit students will be able to:

- 1 Use dimensional analysis to determine units in building services systems
- 2 Discuss the principles of heat and vapour transfer in building services systems
- 3 Evaluate the performance of refrigeration plants and heat exchangers
- 4 Design acoustic environments through the control of noise.

## Essential content

### LO1 Use dimensional analysis to determine units in building services systems

#### *Dimensional analysis*

Units and dimensions

Dimensional analysis

Fundamental and empirical.

#### *Units and dimensions*

Identification of units and dimensions

Force, energy, mass flow, volume flow, acceleration, density, viscosity, specific heat capacity, specific enthalpy, cubical expansion, thermal conductivity, heat flux, rotation, heat transfer coefficient, velocity and area

Checking formation of rational formulae

Identification of dimensions of constants

Rational formulae used in building services applications.

#### *Application of dimensional analysis*

Geometric and dynamical similarity

Derivation of appropriate rational and empirical formulae from known variables

Pump/fan laws

D'Arcy's equation for turbulent flow

Equations for heat transfer by free convection and forced convection

Application of dimensional analysis to the solution of problems in building services applications

Reynolds number

Grashof number

Nusselt number

Prandtl number



## LO2 **Discuss the principles of heat and vapour transfer in building services systems**

*Heat transfer*

Kinetic theory

Modes of heat transfer

Conduction

- Flat surfaces

- Cylindrical surfaces

Free and forced convection and boundary layer

Temperature parameters

- Mean

- Bulk

- Arithmetic mean temperature difference (AMTD)

- Log Mean Temperature Difference (LMTD)

Application of dimensionless groups

Heat transfer coefficients

Heat flux

Radiation

Surface characteristics

- Reflectivity

- Transmissivity

- Absorptivity

- Emissivity

Electromagnetic radiation

- Waveform

- Amplitude

- Frequency

- Wavelength

Black body emissions

Emission from black, grey and selective surfaces

Use of form factors to determine radiant heat exchange

Heat transfer equipment

Human comfort

- Asymmetric radiation

- Plane radiant temperature

- Vector radiant temperature

Solar radiation

- Solar constant

- Solar intensity on surfaces

*Vapour transfer*

Diffusion

Permeability

Vapour resistivity

Moisture transfer

Formation and modes of condensation

- Film-wise

- Drop-wise

- Direct contact

- Homogeneous

Vapour and mass transfer

- Interstitial condensation.

### LO3 Evaluate the performance of refrigeration plants and heat exchangers

#### *Heat exchangers*

Types

Classification

Design

Construction

Applications.

#### *Principles of heat exchange*

Fluid flow paths and flow geometries

Counter flow

Parallel flow

Heat exchange calculations

Log mean temperature difference (LMTD)

Number of transfer units (NTU)

Capacity ration and effectiveness

Heat balance equation

Fouling factors.

#### *Refrigerant plant*

Types

Classification

Design

Construction

Vapour, gas and power cycles

Compression devices

Expansion devices

Performance characteristics.

## *Principles of refrigeration*

Vapour compression diagrams

T-S diagrams

p-H diagrams

p-V diagrams

Thermodynamic processes in refrigeration cycles

Heat pumps and heat engines

Carnot cycle

Performance and analysis of refrigeration/heat pumps in cooling/heating modes

Formulae

Tables

Charts

Mass flow rates

Input power

Capacity

Efficiency

Coefficient of performance

Theoretical/actual cycle arrangements

Ideal/actual pressure-volume diagrams

Reciprocating compression devices

Roto-dynamic compression devices

Compression and expansion curves

Isothermal

Adiabatic

Polytropic

Open and closed systems

First Law of Thermodynamics

Convention of energy transfer

Non-flow energy equation (NFEE)

Specific heat of gases

Steady flow energy equation (SFEE)

Heat engine

## LO4 **Design acoustic environments through the control of noise**

### *Acoustic environments*

Human hearing

Unit of loudness – Phon

Frequency weightings

Reverberation

Absorption coefficients

Noise ratings

Noise criteria curves

Application in acoustic design

Privacy criteria

Concept of speech intelligibility

Statutory and local regulations and criteria

Internal and external environments

Evaluation of sound and vibration effects on the environment in a building

Transmission paths

Design criteria in a building environment

Design solutions for acceptable acoustic environments

Sound reduction index

Insulation principles.

### *Control of noise*

Attenuation characteristics of materials

Components and systems

Acoustic enclosures

Noise control design solutions

Pipework

Ductwork

Grilles

Diffusers

Prime movers

Compressors.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Use dimensional analysis to determine units in building services systems		<b>D1</b> Critically analyse the different outcomes of calculations using dimensionless parameters, highlighting their use in building services
<b>P1</b> Use dimensional analysis to determine units, dimensions and dimensionless groups  <b>P2</b> Identify dimensions, units and constants necessary to complete calculations for building services	<b>M1</b> Apply the outcomes of dimensional analysis to the design and specification of building services systems	
<b>L02</b> Discuss the principles of heat and vapour transfer in building services systems		<b>D2</b> Evaluate the modes of condensation used in building services equipment and the impact of heat and vapour transfer on human comfort in buildings
<b>P4</b> Discuss the principles of conductive, convective and radiant heat transfer through building services equipment and structures  <b>P5</b> Explain the process of vapour transfer through building structures and the efficiency of building services equipment	<b>M2</b> Assess a building services installation to determine the mechanism and performance of heat transfer; through measurement and calculation	

Pass	Merit	Distinction
<p><b>L03</b> Evaluate the performance of refrigeration plants and heat exchangers</p>		<p><b>L03 and L04</b></p> <p><b>D3</b> Critically analyse the relationship between the performance and efficiency of heating or refrigeration plant and the acoustic environment</p>
<p><b>P6</b> Evaluate the performance of refrigeration plant and heat pumps, through the application of scientific principles</p> <p><b>P7</b> Analyse the performance of heat exchangers used in building services</p>	<p><b>M3</b> Compare the efficiency and performance of different forms of refrigeration plant, heat pumps and heat exchangers; through measurement and calculation</p>	
<p><b>L04</b> Design acoustic environments through the control of noise</p>		
<p><b>P8</b> Explain the design criteria for acoustic environments</p> <p><b>P9</b> Design effective acoustic environments for building services installations</p>	<p><b>M4</b> Evaluate, through measurement and calculation, the relative benefit of different forms of sound attenuation, dampening and absorption on reducing noise from building services installations</p>	

## Recommended resources

### Textbooks

- CHADDERTON, D.V. (2012) *Building Services Engineering*. 6th ed. Abingdon, Oxon: Routledge.
- GREENO, R. (1997) *Building Services Technology & Design*. Abingdon, Oxon: Routledge.
- HALL, F.F. and GREENO, R. (2017) *Building Services Handbook*. 9th ed. Abingdon, Oxon: Routledge.
- HORSLEY, M. and KEITH, S. (1996) *Thermofluids*. London: CRC Press.
- MCMULLAN, R. (2012) *Environmental Science in Building*. 7th ed. Basingstoke, Hampshire: Palgrave Macmillan.
- MCDOWELL, R. and MONTGOMERY, R. (2008) *Fundamentals of HVAC Control Systems*. Oxford: Elsevier.
- MOSS, K.J. (2007) *Heat and Mass Transfer in Buildings*. 2nd ed. Abingdon, Oxon: Routledge.
- OUGHTON, D. and WILSON, A. (2015) *Faber & Kell's Heating & Air Conditioning of Buildings*. 11th ed. Abingdon, Oxon: Routledge.

### Websites

- |  |   |
|--|---|
| <a href="http://www.cibse.org">www.cibse.org</a>                           | Chartered Institute of Building Services Engineers<br>(General Reference)     |
| <a href="http://www.bsria.co.uk">www.bsria.co.uk</a>                       | Building Services Research and Information Association<br>(General Reference) |
| <a href="http://www.engineeringtoolbox.com">www.engineeringtoolbox.com</a> | The Engineering Toolbox<br>(General Reference)                                |
| <a href="http://www.gov.uk">www.gov.uk</a>                                 | UK Gov<br>The Building Regulations Approved Documents<br>(General Reference)  |



# Unit 50: Alternative Sustainable Solutions in Construction

<b>Unit code</b>	<b>J/650/4844</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>30</b>

## Introduction

The construction industry seeks to be dynamic and forward thinking but most buildings are still constructed using many of the same materials and processes that have been utilised for centuries.

While there is accumulated knowledge in the use of tried and tested methods they are not always the most efficient or cost effective. This, combined with the fact that the construction industry is one of the largest contributors to emissions, means that it is under increasing pressure and legislative requirements to improve its processes and practices. However, the industry also faces other challenges. As one of the most important sectors of the global economy, it is important that construction is able to meet the demands for housing and institutional and commercial development. Traditional methods of construction will not be sufficient. One of the ways in which the sector is exploring how to address sustainability and increase productivity is through the development and implementation of alternative forms of construction.

Buildings use about 40 per cent of global energy, 25 per cent of global water and 40 per cent of global resources in their construction and operation. Globally, governments have recognised the importance of tackling energy consumption in the built environment and have instituted legislation to address these issues. This has often been supported by financial incentives to implement alternative energy systems and processes. Technologies that harness renewable solutions are now established and are generating power and heat. Along with other innovations, such as heat pumps and biofuel, they are often incorporated into the design for new construction projects.

On successful completion of this unit, students will have examined how the construction industry impacts on the environment, explored alternative construction methods that are fit for purpose and government policy implications, and designed a fit-for-purpose structure using an alternative construction method.

## Learning Outcomes

By the end of this unit, a student will be able to:

- 1 Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies
- 2 Investigate alternative construction methods suitable for new build and retrofit that include alternative energy solutions alongside techniques that improve energy efficiency through the design and specification of modern materials and technologies
- 3 Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation
- 4 Present the retrofit solution for the given building and evaluate the solution and presentation.

## Essential Content

### LO1 Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies

#### *Sustainable development:*

Meeting current and future demands, e.g., Brundtland definition, global demographics, trends and predictions, population growth, urbanisation, UN sustainability development goals, the balance of urban/rural space.

#### *Environmental protection:*

Environmental characteristics, e.g., environment features, global warming, carbon emissions, government and national targets, construction statistics.

#### *Environmental issues:*

Impact of environmental issues on alternative sustainable construction, e.g., climate change, planetary energy balance, the Intergovernmental Panel on Climate Change (IPCC), carbon cycle science, the 2°C climate-change obligation, carbon capture, pollution prevention and management.

#### *Social and economic factors:*

Socio-economic impact of construction, e.g., government influences, construction statistics, housing statistics, affordable homes, urbanisation, greenfield and brownfield sites.

#### *Government policy:*

Local/regional/national planning, policies and regulations, such as approved documents, e.g., Part L, Part F, health and safety legislation, carbon taxes, Bonfield Review, PAS 2035.

#### *Systems thinking and socio-technical systems:*

Politics and economics of sustainable construction, e.g., Kyoto Protocol, Montreal Protocol, Paris Agreement, UN Climate Change Conference (COP), European Union Emissions Trading Scheme.

#### *Sustainability protocols:*

Sustainable construction of homes protocols, e.g., Passivhaus Trust, Building Research Establishment Environmental Assessment Method (BREEAM), Code for Sustainable Homes, retrofit solutions, 2030 Agenda for Sustainable Development.

**LO2 Investigate alternative construction methods suitable for new build and retrofit that include alternative energy solutions alongside techniques that improve energy efficiency through the design and specification of modern materials and technologies**

*Energy demand and security of supply:*

Energy demand and security of construction design solutions, e.g., energy consumption changes, intensity and trends (domestic, industrial, transport, service sectors), factors affecting changes in energy consumption and demand, future demand planning based on trends and needs analysis, risk analysis for energy supplies for UK and local areas.

*Energy reduction and efficiency approaches:*

Reducing energy use, during construction and post construction, e.g., energy saving and reduction schemes, energy-saving technologies available, grants and government schemes, effect of such schemes on supply and demand.

*Low-carbon transport systems:*

Sustainable cities, green building, power storage and distribution, sustainable logistics, waste and recycling, vehicle to grid.

*Construction methods:*

Timber frame, prefabrication, Insulated Concrete Forms (ICFs), Structural Insulated Panels (SIPs), offsite manufacture, modularisation/componentisation, robotics, autonomous building.

*Alternative methods of power generation:*

Solar power, passive solar heating, wind energy technology, ocean energy technology, hydroelectric and micro-hydro power turbine geothermal energy, combined heat and power, heat pumps, storage technologies.

### **LO3 Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation**

#### *Selection of alternative sustainable solution techniques:*

Building types and their needs, consumer needs, technical aspects, economical aspects, social aspects, environmental aspects, manufacturer specifications.

#### *Calculation of the impact of a retrofit design solution and environmental benefits:*

Data analysis and calculations, e.g., review of product specifications, comparison of product, effectiveness of product selection, e.g., price, appearance, longevity, adhering to regulation, U-values, energy-generation values, sustainability, carbon emissions, footprint and neutrality.

#### *Digital planning and design software:*

Construction planning and design software tools to develop design ideas, e.g., AutoCAD, Revit, SketchUp, Photoshop.

#### *Construction information:*

Construction design drawings, e.g., floor plans, elevations, sections, details, sketches, models, perspectives, rendered, photo-realisation.

#### *Financial and environmental implications:*

Cost-benefit analysis, socio-economic factors, financial implications of renewable and conventional energy systems, whole lifecycle costing.

#### *Presentation and skills:*

Consideration of audience, venue, environment, documentation, resources, time management, clarity, concision, voice.

#### **LO4 Present the retrofit solution for the given building and evaluate the solution and presentation**

##### *Communicating results:*

Types of communication methods, e.g., written, verbal, the medium, e.g., different report formats, online, presentation. Multi-media presentation tools, e.g., PowerPoint, Prezi, Google slides, Microsoft Sway, Adobe Spark.

Video conferencing, e.g., Zoom, Adobe Connect, Google Hangouts, Slack video calls.

##### *Communicating skills:*

Verbal and non-verbal communication skills required to meet audience requirements, e.g., eye contact, pitch, pace.

Communicating and persuading internal/external stakeholders, e.g., negotiation and sales skills.

##### *Reflection for learning and practice:*

Differences between reflecting on performance and evaluating a project – the former considers the research process, information gathering and data collection, the latter the quality of the research argument and use of evidence. The cycle of reflection and using reflection to inform future behaviour.

Reflective practice, including feedback, e.g., self-evaluation, peer and expert.

Reflective practice tools, e.g., Schön (1991) Reflection in Action and Reflection on Action, Kolb's Model of Experiential Learning (1984), Rolfe, Freshwater and Jasper 'What' Model (2001), Gibbs' Reflective Cycle (1998).

Reflective writing – writing to avoid generalisation, focusing on personal development and the research journey in a critical and objective way.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p><b>LO1</b> Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies</p>		
<p><b>P1</b> Describe the principals of modern sustainability theory.</p> <p><b>P2</b> Explain the market forces that dictate energy supply and demand.</p>	<p><b>M1</b> Analyse the impact of socio-economic factors that influence a retrofit project.</p>	
<p><b>LO2</b> Investigate alternative construction methods suitable for new build and retrofit that include alternative energy solutions alongside techniques that improve energy efficiency through the design and specification of modern materials and technologies</p>		
<p><b>P3</b> Compare Modern Methods of Construction (MCC).</p> <p><b>P4</b> Describe the available alternative methods of power generation.</p>	<p><b>M2</b> Analyse the selection of MMC in terms of alternative methods of power generation.</p>	
		<p><b>LO1 and LO2</b></p> <p><b>D1</b> Evaluate the factors that inform the selection of a retrofit project.</p>

Pass	Merit	Distinction
<p><b>L03</b> Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation</p>		<p><b>L03</b></p> <p><b>D2</b> Evaluate the selection outcomes of a retrofit proposal in relation to a specific installation.</p>
<p><b>P5</b> Select appropriate solutions for a given retrofit project.</p> <p><b>P6</b> Produce data to draw valid and meaningful conclusions and recommendations from data analysis.</p> <p><b>P7</b> Calculate the impact of a retrofit project.</p>	<p><b>M3</b> Justify solution decisions based on design, funding, sustainability and performance.</p>	
<p><b>L04</b> Present the retrofit solution for the given building and evaluate the solution and presentation</p>		
<p><b>P8</b> Present the recommended retrofit solution using an appropriate format.</p> <p><b>P9</b> Explain possible communication strategies and presentation methods that could be used to inform the recipient of the recommended retrofit solution.</p> <p><b>P10</b> Review feedback given and own performance.</p>	<p><b>M4</b> Reflect on the effectiveness of the chosen communication strategy in presenting the retrofit solution.</p>	<p><b>L04</b></p> <p><b>D3</b> Appraise own performance in managing the retrofit project, draw conclusions and make recommendations that would improve performance in the future.</p>



## Recommended Resources

### Textbooks

COTTERELL, J. and DADEBY, A. (2012) *The Passivhaus Handbook: a practical guide to constructing and retrofitting buildings for ultra-low energy performance*. Devon: Green Books.

ELIZABETH, L. and ADAMS, C. (2005) *Alternative Construction: Contemporary Natural Building Methods*. New Jersey: John Wiley & Sons Ltd.

GARBER, R. (2014) *BIM Design: Realising the Creative Potential of Building Information Modelling*. Chichester: John Wiley & Sons Ltd.

HICKEY, T. (2014) *Construction Technology: Designing Sustainable Homes*. Dublin: Gill & Macmillan Ltd.

HOGAN-O'NEILL, W. (2021) *Prefabricated and Modular Architecture: Aligning Design with Manufacture and Assembly*. Marlborough: The Crowood Press Ltd.

JONES, B. (2015) *Building with Straw Bales: A Practical Manual for Self-Builders and Architects*. Cambridge: Green Books.

PELSMAKERS, S. (2022) *The Environmental Design Pocketbook*. 2nd Edition. RIBA Publishing.

WATTS, A. (2019) *Modern Construction Envelopes: Systems for architectural design and prototyping*. 3rd ed. London: Birkhauser.

### Websites

bregroup.com	BREEAM Assessment Methods and Standards (General Reference)
building.co.uk	Construction articles and papers (General Reference)
constructionnews.co.uk	<i>Construction News</i> articles and papers (General Reference)
sdgs.un.org	Global Sustainable Developments (General Reference)

## **Links**

This unit links to the following related units:

*Unit 3: Science & Materials*

*Unit 6: Construction Information (Drawing, Detailing, Specification)*

*Unit 14: Building Information Modelling*

*Unit 16: Principles of Alternative Energy*

*Unit 35: Alternative Methods of Construction*

# 11 Appendices

# Appendix 1: Glossary of terms used for internally assessed units

This is a summary of the key terms used to define the requirements within units.

Term	Definition
Analyse	<p>Present the outcome of methodical and detailed examination either:</p> <ul style="list-style-type: none"> <li>• breaking down a theme, topic or situation in order to interpret and study the interrelationships between the parts and/or</li> <li>• of information or data to interpret and study key trends and interrelationships.</li> </ul> <p>Analysis can be through activity, practice, written or verbal presentation.</p>
Apply	<p>Put into operation or use.</p> <p>Use relevant skills/knowledge/understanding appropriate to context.</p>
Arrange	Organise or make plans.
Assess	Offer a reasoned judgement of the standard/quality of a situation or a skill informed by relevant facts.
Calculate	Generate a numerical answer with workings shown.
Compare	<p>Identify the main factors relating to two or more items/situations or aspects of a subject that is extended to explain the similarities, differences, advantages and disadvantages.</p> <p>This is used to show depth of knowledge through selection of characteristics.</p>
Compose	Create or make up or form.
Communicate	<p>Convey ideas or information to others.</p> <p>Create/construct skills to make or do something, for example a display or set of accounts.</p>
Create/Construct	Skills to make or do something, for example, a display or set of accounts.
Critically analyse	Separate information into components and identify characteristics with depth to the justification.
Critically evaluate	Make a judgement taking into account different factors and using available knowledge/experience/evidence where the judgement is supported in depth.

Term	Definition
Define	State the nature, scope or meaning.
Describe	Give an account, including all the relevant characteristics, qualities and events.
Discuss	Consider different aspects of a theme or topic, how they interrelate, and the extent to which they are important.
Demonstrate	Show knowledge and understanding.
Design	Plan and present ideas to show the layout/function/workings/object/system/process.
Develop	Grow or progress a plan, ideas, skills and understanding
Differentiate	Recognise or determine what makes something different.
Discuss	Give an account that addresses a range of ideas and arguments.
Evaluate	<p>Work draws on varied information, themes or concepts to consider aspects, such as:</p> <ul style="list-style-type: none"> <li>• strengths or weaknesses</li> <li>• advantages or disadvantages</li> <li>• alternative actions</li> <li>• relevance or significance.</li> </ul> <p>Students' inquiries should lead to a supported judgement showing relationship to its context. This will often be in a conclusion. Evidence will often be written but could be through presentation or activity.</p>
Explain	To give an account of the purposes or reasons.
Explore	Skills and/or knowledge involving practical research or testing.
Identify	Indicate the main features or purpose of something by recognising it and/or being able to discern and understand facts or qualities.
Illustrate	Make clear by using examples or provide diagrams.
Indicate	Point out, show.
Interpret	State the meaning, purpose or qualities of something through the use of images, words or other expression.
Investigate	Conduct an inquiry or study into something to discover and examine facts and information.
Justify	<p>Students give reasons or evidence to:</p> <ul style="list-style-type: none"> <li>• support an opinion</li> <li>• prove something is right or reasonable.</li> </ul>
Outline	Set out the main points/characteristics.

<b>Term</b>	<b>Definition</b>
Plan	Consider, set out and communicate what is to be done.
Produce	To bring into existence.
Reconstruct	To assemble again/reorganise/form an impression.
Report	Adhere to protocols, codes and conventions where findings or judgements are set down in an objective way.
Review	<p>Make a formal assessment of work produced.</p> <p>The assessment allows students to:</p> <ul style="list-style-type: none"> <li>• appraise existing information or prior events</li> <li>• reconsider information with the intention of making changes, if necessary.</li> </ul>
Show how	Demonstrate the application of certain methods/theories/concepts.
Stage and manage	Organisation and management skills, for example, running an event or a [Sector] pitch.
State	Express.
Suggest	Give possible alternatives, produce an idea, put forward, for example, an idea or plan, for consideration.
Undertake/ carry out	Use a range of skills to perform a task, research or activity.

This is a key summary of the types of evidence used for BTEC Higher Nationals:

Type of evidence	Definition
Case study	A specific example to which all students must select and apply knowledge.
Project	A large-scale activity requiring self-direction of selection of outcome, planning, research, exploration, outcome and review.
Independent research	An analysis of substantive research organised by the student from secondary sources and, if applicable, primary sources.
Written task or report	Individual completion of a task in a work-related format, for example, a report, marketing communication, set of instructions, giving information.
Simulated activity/ role play	A multi-faceted activity mimicking realistic work situations.
Team task	Students work together to show skills in defining and structuring activity as a team.
Presentation	Oral or through demonstration.
Production of plan/ Business plan	Students produce a plan as an outcome related to a given or limited task.
Reflective journal	Completion of a journal from work experience, detailing skills acquired for employability.
Poster/leaflet	Documents providing well-presented information for a given purpose.

## Appendix 2: Assessment methods and techniques for Higher Nationals

Assessment technique	Description	Transferable skills development	Formative or Summative
Academic graphic display	This technique asks students to create documents providing well-presented information for a given purpose. Could be a hard or soft copy.	Creativity Written communication Information and communications Technology Literacy	Formative Summative
Case study	This technique present students with a specific example to which they must select and apply knowledge.	Reasoning Critical thinking Analysis	Formative Summative
Discussion forum	This technique allows students to express their understanding and perceptions about topics and questions presented in the class or digitally, for example, online groups, blogs.	Oral/written communication Appreciation of diversity Critical thinking and reasoning Argumentation	Formative
Independent research	This technique is an analysis of research organised by the student from secondary sources and, if applicable, primary sources.	Information and communications technology Literacy Analysis	Formative
Oral/Viva	This technique asks students to display their knowledge of the subject via questioning.	Oral communication Critical thinking Reasoning	Summative
Peer review	This technique asks students to provide feedback on each other's performance. This feedback can be collated for development purposes.	Teamwork Collaboration Negotiation	Formative Summative



<b>Assessment technique</b>	<b>Description</b>	<b>Transferable skills development</b>	<b>Formative or Summative</b>
Presentation	This technique asks students to deliver a project orally or through demonstration.	Oral communication Critical thinking Reasoning Creativity	Formative Summative
Production of an artefact/ performance or portfolio	This technique requires students to demonstrate that they have mastered skills and competencies by producing something. Some examples are business plans, using a piece of equipment or a technique, building models, developing, interpreting, and using maps.	Creativity Interpretation Written and oral communication Interpretation Decision-making Initiative Information and Communications Technology Literacy, etc.	Summative
Project	This technique is a large scale activity requiring self-direction, planning, research, exploration, outcome and review.	Written communication Information Literacy, Creativity, Initiative.	Summative
Role playing	This technique is a type of case study, in which there is an explicit situation established, with students playing specific roles, understanding what they would say or do in that situation.	Written and oral communication Leadership Information literacy Creativity Initiative.	Formative

<b>Assessment technique</b>	<b>Description</b>	<b>Transferable skills development</b>	<b>Formative or Summative</b>
Self-reflection	This technique asks students to reflect on their performance, for example, to write statements of their personal goals for the course at the beginning of the course, what they have learned at the end of the course and their assessment of their performance and contribution; completion of a reflective journal from work experience, detailing skills acquired for employability.	Self-reflection Written communication Initiative Decision-making Critical thinking	Summative
Simulated activity	This technique is a multi-faceted activity based on realistic work situations.	Self-reflection Written communication Initiative Decision-making Critical thinking	Formative Summative
Team assessment	This technique asks students to work together to show skills in defining and structuring an activity as a team.  All team assessment should be distributed equally, each of the group members performing their role, and then the team collates the outcomes, and submits it as a single piece of work.	Collaboration Teamwork Leadership Negotiation Written and oral communication	Formative Summative
Tiered knowledge	This technique encourages students to identify their gaps in knowledge. Students record the main points they have captured well and those they did not understand.	Critical thinking Analysis Interpretation Decision-making Oral and written communication	Formative

<b>Assessment technique</b>	<b>Description</b>	<b>Transferable skills development</b>	<b>Formative or Summative</b>
Time constrained assessment	This technique covers all assessment that needs to be done within a centre-specified time constrained period on-site.	Reasoning Analysis Written communication Critical thinking Interpretation	Summative
Top ten	This technique asks students to create a 'top ten' list of key concepts presented in the assigned reading list.	Teamwork Creativity Analysis Collaboration	Formative
Written task or report	This technique asks students to complete an assignment in a structured written format, for example, a business plan, a report, marketing communication, set of instructions, giving information.	Reasoning Analysis Written communication Critical thinking, interpretation.	Summative

## Appendix 3: Pearson BTEC Higher Nationals in Construction and Apprenticeships

Apprenticeship	Pathway	Qualification
Construction Management	Construction Site Supervision	Pearson BTEC Level 4 Higher National Certificate in Construction (Construction)
Construction Management	Sustainable Built Environment (L4)	Pearson BTEC Level 4 Higher National Certificate in Construction (Construction)
Construction Management	Sustainable Built Environment (L5)	Pearson BTEC Level 5 Higher National Diploma in Construction (Management)
Engineering Environmental Technologies	Construction & Building Services (both pathways)	Pearson BTEC Level 4 HNC Higher National Certificate in Construction (Building Services Engineering)
Surveying	n/a	Pearson BTEC Level 4 Higher National Certificate in Construction (Surveying)

## Appendix 4: Mapping of Pearson BTEC Level 5 Higher National Diploma in Construction against FHEQ Level 5

Key	
KU	Knowledge and Understanding
CS	Cognitive Skills
AS	Applied Skills
TS	Transferable Skills

The qualification will be awarded to students who have demonstrated:

FHEQ Level 5 descriptor		Construction HND Programme Outcome
Knowledge and critical understanding of the well-established principles of their area(s) of study, and of the way in which those principles have developed.	KU1	Knowledge and understanding of the fundamental principles and practices of the contemporary global construction industry.
	KU2	Knowledge and understanding of the external construction environment and its impact upon local, national and global levels of strategy, behaviour, management and sustainability.
	KU3	Understanding and insight into different construction practices, their diverse nature, purposes, structures and operations and their influence upon the external environment.
	KU4	A critical understanding of the ethical, legal, professional, and operational framework within which construction operates.
	KU5	A critical understanding of processes, procedures and practices for effective management of products, services and people.
	KU6	A critical understanding of the evolving concepts, theories and models within the study of Construction across a range of practical and hypothetical scenarios.

FHEQ Level 5 descriptor		Construction HND Programme Outcome
	KU7	An ability to evaluate and analyse a range of concepts, theories and models to make appropriate construction management decisions.
	KU8	An appreciation of the concepts and principles of CPD, staff development, leadership and reflective practice as methods and strategies for personal and people development.
Ability to apply underlying concepts and principles outside the context in which they were first studied, including, where appropriate, the application of those principles in an employment context.	CS1	Apply knowledge and understanding of essential concepts, principles and models within the contemporary global construction industry.
	AS1	Evidence the ability to show client relationship management and develop appropriate policies and strategies to meet stakeholder expectations.
	AS2	Apply innovative construction ideas to develop and create new products or services that respond to the changing nature of the construction industry.
	AS3	Integrate theory and practice through the investigation and examination of practices in the workplace.
	AS4	Develop outcomes for clients/businesses using appropriate practices and data to make justified recommendations.
	CS2	Develop different strategies and methods to show how resources (human, financial and information) are integrated and effectively managed to successfully meet objectives.

FHEQ Level 5 descriptor		Construction HND Programme Outcome
<p>Knowledge of the main methods of enquiry in the subject(s) relevant to the named award, and ability to evaluate critically the appropriateness of different approaches to solving problems in the field of study.</p>	CS3	Critically evaluate current principles of the construction industry, and their application to problem-solving.
	CS4	Apply project management tools/techniques for reporting and planning, control and problem solving.
	KU9	Knowledge and understanding of how the key aspects of construction and engineering influence the development of people and businesses.
	CS5	Critique a range of construction information technology systems and operations and their application to maximise and successfully meet strategic objectives.
	KU10	An understanding of the appropriate techniques and methodologies used to resolve real-life problems in the workplace.
<p>An understanding of the limits of their knowledge, and how this influences analysis and interpretations based on that knowledge.</p>	TS1	Develop a skill-set to enable the evaluation of appropriate actions taken for solving problems in a specific construction context.
	TS2	Self-reflection, including self-awareness; the ability to become an effective self-student and appreciate the value of the self-reflection process.

Typically, holders of the qualification will be able to:

FHEQ Level 5 descriptor		Construction HND Programme Outcomes
Use a range of established techniques to initiate and undertake critical analysis of information, and to propose solutions to problems arising from that analysis.	TS3	Competently use digital literacy to access a broad range of research sources, data and information.
	CS6	Interpret, analyse and evaluate a range of construction data, sources and information to inform evidence-based decision-making.
	CS7	Synthesise knowledge and critically evaluate strategies and plans to understand the relationship between theory and real-world construction scenarios.
Effectively communicate information, arguments and analysis in a variety of forms to specialist and non-specialist audiences, and deploy key techniques of the discipline effectively.	TS4	Communicate confidently and effectively, both orally and in writing both internally and externally with construction professionals and other stakeholders.
	TS5	Communicate ideas and arguments in an innovative manner using a range of digital media.
	AS5	Locate, receive and respond to a variety of information sources (e.g. textual, numerical, graphical and computer-based) in defined contexts.
	TS6	Demonstrate strong interpersonal skills, including effective listening and oral communication skills, as well as the associated ability to persuade, present, pitch and negotiate.
Undertake further training, develop existing skills and acquire new competences that will enable them to assume significant responsibility within organisations.	TS7	Identify personal and professional goals for Continuing Professional Development in order to enhance competence to practice within a chosen construction field.
	TS8	Take advantage of available pathways for Continuing Professional Development through higher education and Professional Body Qualifications.



Holders will also have:

FHEQ Level 5 descriptor		Construction HND Programme Outcomes
The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and decision-making.	TS9	The ability to organise significant activities appropriately into discrete tasks and to set and prioritise goals.
	TS10	The ability to organise time effectively to plan and undertake tasks efficiently in the context of the sector
	TS11	The ability to take decisions, based on critical analysis of information from a range of appropriate sources.

## Appendix 5: HNC/HND Construction Programme Outcomes for Students

Unit	Knowledge and Understanding										Cognitive Skills								Applied Skills					Transferable Skills																
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12					
1	X		X		X	X	X	X					X	X						X			X	X						X		X								
2	X	X	X				X				X					X					X													X						
3		X	X	X	X		X				X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
4	X	X	X	X	X	X		X			X	X		X				X	X		X			X		X		X		X	X					X				
5	X	X	X	X		X	X	X	X	X	X		X			X		X		X		X	X	X		X		X		X		X				X				
6					X	X	X			X					X	X	X				X		X	X		X						X			X					
7	X		X		X		X			X			X		X	X				X		X	X		X		X									X				
8										X	X				X						X		X			X										X				
9	X	X	X	X						X	X		X			X					X	X	X														X			
10	X	X	X	X						X	X		X			X					X	X	X														X			
11	X	X	X		X		X		X	X	X			X	X						X	X	X			X											X			
12	X	X		X	X		X	X	X		X	X	X	X		X	X		X		X	X	X	X	X			X									X			
13	X		X	X	X	X	X		X	X	X	X		X		X	X		X		X	X	X	X			X	X										X		
14	X	X	X			X					X		X		X	X					X	X	X	X			X								X			X		
15	X	X	X				X		X	X	X	X				X					X		X		X			X	X									X		
16	X	X	X	X		X	X		X	X	X				X	X				X		X	X	X	X			X	X									X		
17	X	X	X	X	X	X	X			X	X	X	X			X	X				X	X	X	X	X		X											X		
18	X	X	X	X		X	X			X	X		X		X	X	X				X	X	X	X	X		X		X										X	
19	X	X	X	X		X	X				X		X		X	X					X		X	X															X	
20	X	X	X			X				X	X		X		X	X	X				X	X	X	X	X		X		X	X		X							X	
21	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X			X		X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
22			X		X			X				X		X								X		X	X		X		X							X	X		X	
23	X	X		X	X						X	X		X	X						X	X	X	X													X		X	

Unit	Knowledge and Understanding								Cognitive Skills											Applied Skills						Transferable Skills											
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	
24	X	X	X	X	X	X		X			X	X		X				X	X		X	X		X	X	X	X	X		X			X	X			
25	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X		X	X	X	X		X	X					X		X		X		
26	X	X	X			X					X		X		X	X				X	X	X	X		X						X		X		X		
27	X	X	X				X				X				X					X												X			X		
28										X	X				X					X		X			X								X				
29	X	X	X		X		X		X	X	X		X		X	X	X				X		X	X		X	X							X		X	
30	X	X					X			X	X		X			X	X				X		X	X		X								X		X	
31	X	X	X	X						X	X		X			X					X	X	X											X		X	
32	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X			X	X	X	X	X	X		X	X							X		X
33	X	X	X	X		X	X			X	X		X		X	X	X			X	X	X	X	X		X		X							X		X
34	X		X	X	X	X	X		X	X	X	X		X		X	X		X		X	X	X	X		X	X								X		X
35	X	X	X	X	X	X	X		X		X		X			X	X			X	X	X	X	X		X	X	X						X	X		X
36	X	X	X			X					X		X		X	X				X	X	X	X		X							X		X		X	
37	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X			X	X	X	X	X		X						X	X	X		X	
38	X	X	X					X		X	X		X				X	X			X		X	X					X	X	X	X	X		X		X
39	X	X	X	X	X		X		X	X	X		X	X		X	X		X		X	X	X	X		X	X										X
40	X	X	X	X		X	X			X	X		X		X	X	X			X	X	X	X	X		X		X							X		X
41	X	X	X	X			X		X	X	X				X	X		X			X	X	X	X		X	X								X		X
42	X	X	X	X		X	X		X	X	X		X	X		X	X		X		X	X	X		X	X					X	X	X		X		X
43	X	X	X	X			X			X	X		X			X					X	X	X	X		X		X						X	X		X
44	X		X		X		X			X			X		X	X				X			X	X		X								X	X		X
45	X	X	X	X	X	X	X		X	X	X	X	X			X	X		X		X	X	X	X		X	X	X				X	X				X
46		X	X	X	X		X				X	X		X	X		X	X			X	X	X	X	X	X		X	X			X	X		X		

Unit	Knowledge and Understanding								Cognitive Skills											Applied Skills						Transferable Skills												
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11		
47	X	X	X			X					X		X		X	X				X	X	X	X			X							X	X	X			X
48	X		X			X	X		X	X	X	X	X				X				X	X	X	X		X	X									X		X
49	X		X			X	X		X	X	X	X	X				X				X	X	X	X		X	X									X		X

## Appendix 6: Transferable skills mapping

### Pearson BTEC Level 4 Higher National Certificate in Construction: mapping of transferable employability and academic study skills

Skill Set	Cognitive skills						Intra-personal Skills					Interpersonal Skills		
Unit	Problem Solving	Critical Thinking/ Analysis	Decision Making	Effective Communication	Digital Literacy	Numeracy	Creativity	Plan Prioritise	Self Management	Independent learning	Self Reflection	Team Work	Leadership	Cultural Awareness
1	X		X	X	X			X	X	X	X			
2		X			X	X			X	X				
3		X	X			X		X		X				X
4		X	X	X	X			X	X	X			X	X
5		X	X		X					X		X	X	
6	X	X		X	X	X	X		X	X				
7	X	X		X	X	X			X					
8	X	X	X	X	X	X				X				
9	X	X	X	X	X	X	X	X	X					
10	X	X	X	X	X	X	X	X	X					
11	X		X		X	X			X					
12		X	X	X				X	X			X	X	X
13	X	X	X		X	X		X				X		
14	X	X		X	X	X	X	X				X		X

Skill Set	Cognitive skills						Intra-personal Skills					Interpersonal Skills		
Unit	Problem Solving	Critical Thinking/ Analysis	Decision Making	Effective Communication	Digital Literacy	Numeracy	Creativity	Plan Prioritise	Self Management	Independent learning	Self Reflection	Team Work	Leadership	Cultural Awareness
15	X	X	X	X			X	X						X
16	X	X	X	X	X	X	X	X						
17	X	X	X	X			X	X						X
18	X	X		X	X	X	X	X	X					
19	X	X		X	X	X	X	X	X					
20	X	X			X	X	X					X		
21	X	X	X	X	X		X	X	X			X	X	
22	X	X	X	X			X	X	X	X	X	X	X	
23	X	X	X	X	X			X				X	X	X
24		X	X	X			X	X	X			X	X	
25		X	X	X				X				X	X	
26	X	X			X	X	X	X				X		
27	X	X	X		X		X	X				X		
28	X	X			X	X	X							
29	X	X	X		X		X	X		X				
30	X	X	X		X	X	X	X						
31	X	X	X	X		X	X	X				X		X
32	X	X	X	X	X		X	X						

Skill Set	Cognitive skills						Intra-personal Skills					Interpersonal Skills		
Unit	Problem Solving	Critical Thinking/ Analysis	Decision Making	Effective Communication	Digital Literacy	Numeracy	Creativity	Plan Prioritise	Self Management	Independent learning	Self Reflection	Team Work	Leadership	Cultural Awareness
33	X	X		X		X	X	X				X		
34		X	X	X	X	X		X		X				
35	X	X	X	X			X	X		X			X	
36		X		X	X									X
37		X	X		X	X		X	X					X
38		X	X	X				X	X	X	X	X	X	
39		X	X			X	X	X		X				
40	X	X	X	X		X		X		X				X
41		X	X	X	X			X		X				X
42	X	X	X	X	X					X		X		
43	X	X	X		X	X	X	X						
44	X	X	X	X	X					X				
45		X	X		X			X				X	X	
46	X	X	X	X		X				X				
47		X		X	X			X				X		
48			X	X		X	X		X					
49	X		X	X		X	X		X					

## Appendix 7: Legacy units

NOTE: This unit is suitable for students registered **BEFORE the 2019/20 academic year**.

Students registered **FOR the 2019/20 (or later) academic year** must undertake J/617/6366; found in Section 10 of this programme specification.

### Unit 8: Mathematics for Construction

**Unit code** K/615/1394

**Unit level** 4

**Credit value** 15

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#### Introduction

The aim of this unit is to develop students' skills in the mathematical principles and theories that underpin the civil engineering and building services curriculum.

Students will be introduced to mathematical methods and statistical techniques in order to analyse and solve problems within a construction engineering context.

Topics included in this unit are: dimensional analysis, arithmetic and geometric progressions wave and vector functions, differential and integral calculus, binomial and normal distribution, sinusoidal waves, and trigonometric and hyperbolic identities, among other topics.

On successful completion of this unit students will be able to employ mathematical methods within a variety of contextualised examples, interpret data using statistical techniques, and use analytical and computational methods to evaluate and solve engineering construction problems. Therefore, they will also gain crucial employability skills such as critical thinking, problem solving, analysis, reasoning, and data interpretation.



## Learning Outcomes

By the end of this unit students will be able to:

1. Identify the relevance of mathematical methods to a variety of conceptualised construction examples.
2. Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages.
3. Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective construction applications.
4. Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus.

## Essential Content

### LO1 Identify the relevance of mathematical methods to a variety of conceptualised construction examples

*Mathematical concepts. Dimensional analysis.*

*Arithmetic and geometric progressions. Functions.*

*Exponential, logarithmic, circular and hyperbolic functions.*

### LO2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages

*Summary of data.*

*Mean and standard deviation of grouped data. Pearson's correlation coefficient.*

*Linear regression. Probability theory.*

*Binomial and normal distribution. Hypothesis testing for significance.*

### LO3 Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective construction applications

*Sinusoidal waves.*

*Sine waves and applications. Trigonometric and hyperbolic identities. Vector functions.*

*Vector notation and properties. Representing quantities in vector form. Vectors in three dimensions.*

### LO4 Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus

*Differential calculus. Differentiation of functions. Stationary points.*

*Rates of change. Integral calculus.*

*Definite and indefinite integration.*

*Integrating to determine area and common functions. Integration by substitution.*

*Exponential growth and decay.*

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Identify the relevance of mathematical methods to a variety of conceptualised construction examples		<b>LO1 LO2</b> <b>D1</b> Present statistical data in a method that can be understood by a non-technical audience.
<b>P1</b> Apply dimensional analysis techniques to solve complex problems. <b>P2</b> Generate answers from contextualised arithmetic and geometric progressions. <b>P3</b> Determine the solutions of equations using exponential, trigonometric and hyperbolic functions.	<b>M1</b> Apply dimensional analysis to derive equations.	
<b>LO2</b> Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages		
<b>P4</b> Summarise data by calculating mean and standard deviation, and simplify data into graphical form. <b>P5</b> Calculate probabilities within both binomially distributed and normally distributed random variables.	<b>M2</b> Interpret the results of a statistical hypothesis test conducted from a given scenario.	
<b>LO3</b> Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective construction applications		<b>D2</b> Model the combination of sine waves graphically and analyse the variation between graphical and analytical methods.
<b>P6</b> Solve construction problems relating to sinusoidal functions. <b>P7</b> Represent construction quantities in vector form, and apply appropriate methodology to determine construction parameters.	<b>M3</b> Apply compound angle identities to separate waves into distinct component waves.	

Pass	Merit	Distinction
<p><b>LO4</b> Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus</p>		
<p><b>P8</b> Determine rates of change for algebraic, logarithmic and circular functions.</p> <p><b>P9</b> Use integral calculus to solve practical problems relating to engineering.</p>	<p><b>M4</b> Formulate predictions of exponential growth and decay models using integration methods.</p>	

## Recommended Resources

### Textbooks

SINGH, K. (2011) *Engineering Mathematics Through Applications*. 2nd Ed. Basingstoke: Palgrave Macmillan.

STROUD, K. A. and BOOTH, D.J. (2013) *Engineering Mathematics*. 7th Ed. Basingstoke: Palgrave Macmillan.

### Websites

mathcentre.ac.uk                      Mathcentre (Training/Tutorials)

mathtutor.ac.uk                      Mathtutor (Training/Tutorials)

### Links

This unit links to the following related units:

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation and Air Conditioning Design & Installation*

*Unit 17: Principles of Public Health Engineering*

*Unit 18: Civil Engineering Technology*

*Unit 19: Principles of Electrical Design & Installation*

*Unit 28: Further Mathematics for Construction*

*Unit 30: Advanced Structural Design*

*Unit 31: Advanced Heating, Ventilation and Air Conditioning Design & Installation*

*Unit 33: Advanced Electrical Design & Installation*

*Unit 43: Hydraulics*

**NOTE:** This unit is suitable for teaching and assessment between September 2018 to August 2020 and is here for reference purposes.

Students registered FOR the 2020/21 (or later) academic year must be assessed using the unit descriptor; found in Section 10 of this programme specification.

## Unit 28: Further Mathematics for Construction

<b>Unit code</b>	<b>M/615/1414</b>
<b>Unit level</b>	<b>5</b>
<b>Credit value</b>	<b>15</b>

### Introduction

The understanding of more advanced mathematics is important within the civil engineering and building services engineering industries. Students must be introduced to additional topics that will be relevant to them as they progress to the next level of their studies; advancing their knowledge of mathematical theory gained in the Level 4 *Unit 8: Mathematics for Construction*.

The aim of this unit is to teach students to analyse and model civil engineering or building services engineering situations using mathematical techniques.

Among the topics included in this unit are: number theory, complex numbers, matrix theory, linear equations, numerical integration, numerical differentiation, and graphical representations of curves for estimation within an engineering context. Finally, students will expand their knowledge of calculus to discover how to model and solve problems using first and second order differential equations.

On successful completion of this unit students will be able to use applications of number theory in practical construction situations, solve systems of linear equations relevant to construction applications using matrix methods, approximate solutions of contextualised examples with graphical and numerical methods, and review models of construction systems using ordinary differential equations. As a result they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

## **Learning Outcomes**

By the end of this unit students will be able to:

1. Apply instances of number theory in practical construction situations
2. Solve systems of linear equations relevant to construction applications using matrix methods
3. Approximate solutions of contextualised examples with graphical and numerical methods
4. Review models of construction systems using ordinary differential equations.

## Essential Content

### LO1 **Apply instances of number theory in practical construction situations**

#### *Number theory:*

Bases of a number (Denary, Binary, Octal, Duodecimal, Hexadecimal) and converting between bases

Types of numbers (Natural, Integer, Rational, Real, Complex)

The modulus, argument and conjugate of complex numbers

Polar and exponential form of complex numbers

The use of de Moivre's Theorem in engineering

Complex number applications e.g. electric circuit analysis, information and energy control systems.

### LO2 **Solve systems of linear equations relevant to construction applications using matrix methods**

#### *Matrix methods:*

Introduction to matrices and matrix notation

The process for addition, subtraction and multiplication of matrices

Introducing the determinant of a matrix and calculating the determinant for a 2x2 matrix

Using the inverse of a square matrix to solve linear equations

Gaussian elimination to solve systems of linear equations (up to 3x3).

### LO3 **Approximate solutions of contextualised examples with graphical and numerical methods**

#### *Graphical and numerical methods:*

Standard curves of common functions, including quadratic, cubic, logarithm and exponential curve

Systematic curve sketching knowing the equation of the curve

Using sketches to approximate solutions of equations

Numerical analysis using the bisection method and the Newton–Raphson method

Numerical integration using mid-ordinate rule, the trapezium rule and Simpson's rule.



#### **LO4 Review models of construction systems using ordinary differential equations**

*Differential equations:*

Formation and solutions of first-order differential equations

Applications of first-order differential equations e.g. RC and RL electric circuits, Newton's laws of cooling, charge and discharge of electrical capacitors, and complex stresses and strains

Formation and solutions of second-order differential equations

Applications of second-order differential equations e.g. mass-spring-damper systems, information and energy control systems, heat transfer, automatic control systems and beam theory and RLC circuits

Introduction to Laplace transforms for solving linear ordinary differential equations

Applications involving Laplace transforms, such as electric circuit theory, load frequency control, harmonic vibrations of beams and engine governors.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Apply instances of number theory in practical construction situations		<b>D1</b> Test the correctness of a trigonometric identity using de Moivre's Theorem
<b>P1</b> Apply addition and multiplication methods to numbers that are expressed in different base systems	<b>M1</b> Deduce solutions of problems using de Moivre's Theorem	
<b>P2</b> Solve construction problems using complex number theory	<b>P3</b> Perform arithmetic operations using the polar and exponential form of complex numbers	
<b>LO2</b> Solve systems of linear equations relevant to construction applications using matrix methods		<b>D2</b> Validate all analytical matrix solutions using appropriate computer software
<b>P4</b> Ascertain the determinant of a 3x3 matrix	<b>M2</b> Determine solutions to a set of linear equations using the inverse matrix method	
<b>P5</b> Solve a system of three linear equations using Gaussian elimination		
<b>LO3</b> Approximate solutions of contextualised examples with graphical and numerical methods		<b>D3</b> Critique the use of numerical estimation methods, commenting on their applicability and the accuracy of the methods
<b>P6</b> Estimate solutions of sketched functions using a graphical estimation method	<b>M3</b> Solve construction problems and formulate mathematical models using first-order differential equations	
<b>P7</b> Identify the roots of an equation using two different iterative techniques		
<b>P8</b> Determine the numerical integral of construction functions using two different methods		

Pass	Merit	Distinction
<b>LO4</b> Review models of construction systems using ordinary differential equations		<b>D4</b> Evaluate first- and second-order differential equations when generating the solutions to construction situations
<b>P9</b> Determine first-order differential equations using analytical methods	<b>M4</b> Evaluate how different models of construction systems use first-order differential equations to solve structural or environmental problems	
<b>P10</b> Determine second-order homogeneous and non-homogenous differential equations using analytical methods		
<b>P11</b> Calculate solutions to linear ordinary differential equations using Laplace transforms		

## Recommended Resources

### Textbooks

BIRD, J. (2014) *Higher Engineering Mathematics*. 7th ed. London: Routledge.

SINGH, K. (2011) *Engineering Mathematics Through Applications*. Basingstoke: Palgrave Macmillan.

STROUD, K.A. and BOOTH, D.J. (2013) *Engineering Mathematics*. 7th ed. Basingstoke: Palgrave Macmillan.

### Websites

[www.mathcentre.ac.uk](http://www.mathcentre.ac.uk) MathCentre  
(General Reference)

[www.mathtutor.ac.uk](http://www.mathtutor.ac.uk) MathTutor  
(General Reference)

### Links

This unit links to the following related units:

*Unit 3: Science & Materials*

*Unit 7: Surveying, Measuring & Setting-out*

*Unit 8: Mathematics for Construction*

*Unit 9: Principles of Heating Services Design & Installation*

*Unit 10: Principles of Ventilation & Air Conditioning Design & Installation*

*Unit 11: Measurement & Estimating*

*Unit 17: Principles of Public Health Engineering*

*Unit 29: Geotechnics & Soil Mechanics*

*Unit 30: Advanced Structural Design*

*Unit 31: Advanced Heating, Ventilation & Air Conditioning Design & Installation*

*Unit 33: Advanced Electrical Design & Installation*

*Unit 34: Advanced Quantities for Complex Building Projects*

*Unit 42: Highway Engineering*

*Unit 44: Advanced Surveying & Measurement*

## Appendix 8: Recognition of Prior Learning

**QCF Pearson BTEC Level 4 Higher National Certificate in Construction and the Built Environment unit content mapped to the Level 4 units available in the RQF Pearson BTEC Level 4 Higher National Certificate in Construction/Construction and the Built Environment.**

### HNCs in Construction/Construction and the Built Environment: Unit Mapping Overview

This mapping document is designed to support centres who wish to recognise student achievement in older QCF Higher Nationals within the new RQF suites. The document demonstrates where content is covered in the new suite, and where there is new content to cover to ensure full coverage of learning outcomes.

P – Partial mapping (some topics from the old unit appear in the new unit)

X – Full mapping + new (all the topics from the old unit appear in the new unit, but new unit also contains new topic(s))

N – New unit

Unit no.	Unit title New RQF HN programme	Maps to unit number on existing QCF HN programme	Level of similarity between units
1	Individual Project	1	P
		2	P
		6	P
		13	P
		41	P
		42	P
2	Construction Technology	1	P
		7	P
		10	P
		33	P
3	Science & Materials	1	P
		2	P
		6	P
		13	P

Unit no.	Unit title New RQF HN programme	Maps to unit number on existing QCF HN programme	Level of similarity between units
		41	P
		42	P
4	Construction Practice & Management	6	P
		16	P
		21	P
5	Legal & Statutory Responsibilities in Construction	9	X
		16	P
6	Construction Information (Drawing, Detailing, Specification)	16	P
		23	P
		28	P
		29	P
		49	P
7	Surveying, Measuring & Setting-out	3	P
		27	X
8	Mathematics for Construction	3	X
9	Principles of Heating Services Design & Installation	42	X
10	Principles of Ventilation and Air-conditioning Design & Installation	10	P
		41	X
11	Measurement & Estimating	16	P
		18	X
12	Financial Management and Business Practices in Construction	9	P
13	Tender & Procurement	16	X
		21	P

<b>Unit no.</b>	<b>Unit title New RQF HN programme</b>	<b>Maps to unit number on existing QCF HN programme</b>	<b>Level of similarity between units</b>
14	Building Information Modelling	21	P
		28	P
15	Principles of Refurbishment	1	P
		7	P
16	Principles of Alternative Energy		N
17	Principles of Public Health Engineering	46	P
18	Civil Engineering Technology	33	X
19	Principles of Electrical Design & Installation	43	X
		50	P
20	Principles of Structural Design		N
21	Site Supervision and Operations	6	P
		7	P
		21	P

## HNCs in Construction/Construction and the Built Environment: Unit Mapping Depth

The RQF Pearson BTEC Level 4 HNC Certificate in Early Childhood Education and Care mapped against the current QCF Pearson BTEC Level 4 HNC Certificate in Advanced Practice in Early Years Education units (specification end date 30/11/18).

RQF HNC Units		QCF HNC units		Mapping comments	
No	RQF unit title	No	QCF unit title	QCF LOs	RQF LOs
1	Individual Project	1	Design Principles and Application for Construction and the Built Environment	26	1
		4	Design Procedures for Construction	24	2
					3
		3	The Use of Information and Communication Technology for Construction and the Built Environment	35	4
2	Construction Technology	1	Design Principles and Application for Construction and the Built Environment	5	1
		3	Construction and Maintenance of Buildings	7	2
		33	Civil Engineering Technology	1,2	
		13	Environmental Impact of Construction		3
		7	Construction and Maintenance of Buildings	4	4
		0	Building Services Design, Installation and Maintenance in Construction	2	
3	Science & Materials	6	Health, Safety & Welfare for Construction and the Built Environment	1,2	1
		13	Environmental Impact of Construction	1	2
		2	Science and Materials for Construction and the Built Environment	1	



RQF HNC Units		QCF HNC units		Mapping comments	
No	RQF unit title	No	QCF unit title	QCF LOs	RQF LOs
		2	Science and Materials for Construction and the Built Environment	1	3
		42	Low Pressure Hot Water Heating for Non-domestic Buildings	1,2	4
		41	Air Conditioning for Industrial and Commercial Buildings	1,2,3	
4	Construction Practice & Management				1
		16	Measuring, Tendering and Estimating for Construction and the Built Environment	1,4	2
		21	Specification and Contract Documentation for Construction	4	3
		6	Health, Safety & Welfare for Construction and the Built Environment	1,2	4
5	Legal & Statutory Responsibilities in Construction	9	Law and Contract for Construction and the Built Environment	4	1
					2
				1,2	3
		16	Measuring, Tendering and Estimating for Construction and the Built Environment	4	4
6	Construction Information (Drawing, Detailing, Specification)	29	Computer-aided Design for Construction	2,3	1
		23	Advanced Measurement for Construction	5	2
		16	Measuring, Tendering and Estimating for Construction and the Built Environment	1	
		28	IT Applications for Construction	5	3

RQF HNC Units		QCF HNC units		Mapping comments	
No	RQF unit title	No	QCF unit title	QCF LOs	RQF LOs
		49	Electrical and Electronic Control Principles for Building Services Engineering	2	4
7	Surveying, Measuring & Setting-out	27	Site Surveying procedures for Construction and the Built Environment	1,2	1
		27		1,3	2
		3	Science and Materials for Construction and the Built Environment	2	3
					4
8	Mathematics for Construction	3	Applied Mathematics for Construction and the Built Environment	4	1
				3	2
				1	3
					4
9	Principles of Heating Services Design & Installation	42	Low Pressure Hot Water Heating for Non-domestic Buildings	1	1
				2	2
				3	3
				4	4
10	Principles of Ventilation and Air-conditioning Design & Installation	10	Building Services Design, Installation and Maintenance in Construction	1	1
		41	Air Conditioning for Industrial and Commercial Buildings	1	2
				3	3
				4	4
11	Measurement & Estimating	16	Measuring, Tendering and Estimating for Construction and the Built Environment	1	1
		18	Measurement Processes for Construction	1	

RQF HNC Units		QCF HNC units		Mapping comments	
No	RQF unit title	No	QCF unit title	QCF LOs	RQF LOs
		16	Measuring, Tendering and Estimating for Construction and the Built Environment	2,3	2
		18	Measurement Processes for Construction	1	
		16	Measuring, Tendering and Estimating for Construction and the Built Environment	3	3
					4
12	Financial Management and Business Practices in Construction	9	Applied Mathematics for Construction and the Built Environment	3	1
					2
		9	Applied Mathematics for Construction and the Built Environment	3	3
					4
13	Tender & Procurement	16	Measuring, Tendering and Estimating for Construction and the Built Environment	1	1
				4	2
		21	Specification and Contract Documentation for Construction	1,3	3
		16	Measuring, Tendering and Estimating for Construction and the Built Environment	3	4
14	Building Information Modelling				1
		28	IT Applications for Construction	1,5	
		21	Specification and Contract Documentation for Construction	1	3
					4
15	Principles of Refurbishment	7	Construction and Maintenance of Buildings	4	1

RQF HNC Units		QCF HNC units		Mapping comments	
No	RQF unit title	No	QCF unit title	QCF LOs	RQF LOs
					2
					3
		1	Design Principles and Application for Construction and the Built Environment	1	4
16	Principles of Alternative Energy				1
					2
					3
					4
17	Principles of Public Health Engineering	46	Piped Distribution Services for Non-domestic Buildings	2	1
					2
					3
		46	Piped Distribution Services for Non-domestic Buildings	2,3,4	4
18	Civil Engineering Technology	33	Civil Engineering Technology	1,2	1
				3	2
				5	3
					4
19	Principles of Electrical Design & Installation	43	Electricity and Lighting for Building Services Engineering	2,3	1
				1,2,4	
		50	Electrical Installation for Building Services Engineering	3	2
		43	Electricity and Lighting for Building Services Engineering	2	3
				1	4
20	Principles of Structural Design				

RQF HNC Units		QCF HNC units		Mapping comments	
No	RQF unit title	No	QCF unit title	QCF LOs	RQF LOs
21	Site Supervision & Operations	21	Specification and Contract Documentation for Construction	2	1
		7	Construction and Maintenance of Buildings	4	2
		6	Health, Safety and Welfare for Construction and the Built Environment	1,2,3	3
					4

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