Unit Descriptors for the Pearson BTEC Higher Nationals Construction Suite

Issue 4

For use with:

Pearson BTEC Higher Nationals in Construction Management for England

Pearson BTEC Higher Nationals in Architectural Technology for England

Pearson BTEC Higher Nationals in Modern Methods of Construction for England

Pearson BTEC Higher Nationals in Quantity Surveying for England

Pearson BTEC Higher Nationals in Civil Engineering for England

Pearson BTEC Higher Nationals in Building Services Engineering for England

Pearson BTEC Higher Nationals in Construction Management

Pearson BTEC Higher Nationals in Architectural Technology

Pearson BTEC Higher Nationals in Modern Methods of Construction

Pearson BTEC Higher Nationals in Quantity Surveying

Pearson BTEC Higher Nationals in Civil Engineering

Pearson BTEC Higher Nationals in Building Services Engineering

About Pearson

We are the world's leading learning company operating in countries all around the world. We provide content, assessment and digital services to learners, educational institutions, employers, governments and other partners globally. We are committed to helping equip learners with the skills they need to enhance their employability prospects and to succeed in the changing world of work. We believe that wherever learning flourishes so do people.

Summary of Construction Suite Unit Descriptors Booklet Issue 4 changes

Summary of changes made between previous issue and this current issue	Page number
Contents page and *4.0 Unit descriptors* section New unit added *Unit 4001DB: Construction Design Project Design and Build Technician (Pearson-set)*	 24

Summary of Construction Suite Unit Descriptors Booklet Issue 3 changes

Summary of changes made between Issue 2 and Issue 3	Page number
Contents page and *4.0 Unit descriptors* section New unit added *Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)*	 15
4.0 Unit Descriptors – Unit 10 Measurement & Estimating Corrected typo in Assessment Criteria D2	100
4.0 Unit Descriptors – Unit 12 Tender & Procurement Corrected introduction to match unit LOs	116
4.0 Unit Descriptors – Unit 13 Building Information Modelling Corrected terminology to suit current standard ISO 19650 Removed PAS 1192 standards Updated web resource and unit links	124
4.0 Unit Descriptors – Unit 17 Civil Engineering Security added to essential content Additional link added to web resources *Unit 7: Surveying, measuring & Setting-out* added to *Links*	151

Earlier issue(s) show(s) previous changes.

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.

Contents

1.0 Introduction

The unit descriptors included in this document are for use with the following qualifications:

- Pearson BTEC Higher Nationals in Construction Management for England
- Pearson BTEC Higher Nationals in Architectural Technology for England
- Pearson BTEC Higher Nationals in Modern Methods of Construction for England
- Pearson BTEC Higher Nationals in Quantity Surveying for England
- Pearson BTEC Higher Nationals in Civil Engineering for England
- Pearson BTEC Higher Nationals in Building Services Engineering for England
- Pearson BTEC Higher Nationals in Construction Management
- Pearson BTEC Higher Nationals in Architectural Technology
- Pearson BTEC Higher Nationals in Modern Methods of Construction
- Pearson BTEC Higher Nationals in Quantity Surveying
- Pearson BTEC Higher Nationals in Civil Engineering
- Pearson BTEC Higher Nationals in Building Services Engineering

1.1 Qualifications indicated ‘for England’

Qualifications that are indicated as ‘for England’ are designed to meet the requirements of specific Occupational Standards. Meeting the requirements of the Occupational Standards relates to:

- qualifications that are ‘quality marked’ as Higher Technical Qualifications (HTQ)
- qualifications that meet the knowledge, skills, and behaviours for identified job roles that are associated with the relevant Occupational Standards.

1.2 Qualifications not indicated "for England"

Qualifications that are *not* indicated as ‘for England’ can be delivered at any centre, in any country, including those in England. However, in England these qualifications are not ‘quality marked’ as Higher Technical Qualifications by the Institute for Apprenticeships and Technical Education (IfATE).

2.0 Programme structures

Programme structures define the unit combinations required for a given qualification. Unit combinations are defined in *Section 6 Programme structures* in the relevant programme specification for each qualification.

3.0 The unit descriptor

The unit descriptor is how we define the individual units of study that make up a Higher National qualification. Students will complete the units included in the programme you offer at your centre.

We have described each part of the unit as follows.

Unit title	A general statement of what the unit will cover.
Unit code	The Ofqual unit code.
Unit type	There are three unit types. • core (mandatory to all pathways) • specialist (mandatory to specific pathways) • optional (available to most pathways).
Unit level	All our Pearson BTEC Higher National units are at Level 4 or 5.
Credit value	The credit value relates to the total qualification time (TQT) and unit learning hours (ULH). It is easy to calculate: • 1 credit = 10 ULH, so • 15 credits = 150 ULH. To complete a Higher National Certificate or Diploma, students must achieve all of the credits required.
Introduction	Some general notes on the unit: • setting the scene • stating the purpose, and • outlining the topics and skills gained through the unit.
Learning Outcomes	These clearly explain what students will be able to do after completing the unit. There are usually four Learning Outcomes for each unit.
Essential Content	This section covers the content that students can expect to study as they work towards achieving the Learning Outcomes.

Learning Outcomes and Assessment Criteria	Tutors can refer to this table when grading assignments. The table connects the unit's Learning Outcomes with the student's work. Assignments can be graded at 'Pass' (P), 'Merit' (M) and 'Distinction' (D), depending on the quality of the student's work.
Recommended Resources	Lists the resources that students should use to support their study for this unit. It includes books, journals and online material. The programme tutor may also suggest resources, particularly for local information.

Web resources – referencing

Some units have web resources as part of their Recommended Resources list. Hyperlinking to these resources directly can cause problems, as their locations and addresses may change. To avoid this problem, students and tutors should reference web resources as follows.

[1] A link to the main page of the website

[2] The title of the site

[3] The section of the website where the resource can be found

[4] The type of resource it is, for example:

- research
- general reference
- tutorials
- training
- e-books
- report
- wiki
- article
- datasets
- development tool
- discussion forum.

Examples

[1] www.designingbuildings.co.uk

[2] Designing Buildings Wiki

[3] Subjects

[4] (General reference)

4.0 Unit descriptors

Unit 1: Construction Design Project (Pearson-set)

Level: 4

Credits: 15

Ofqual Code: F/618/8080

Introduction

The success of any project relies on the development of a good design and the technical information to allow the project to be built. The aim of this unit is to help students to appreciate and be aware of the design process and the information required to communicate the design itself, specify and quantify materials, provide instructions for the assembly and erection, and facilitate precise costing and project management.

Topics included in this unit are: project phases; construction drawing; detailing; Computer Aided Design (CAD); Building Information Modelling (BIM); schedules; specifications; bills of quantities; information collaboration.

On successful completion of the unit, students will be able to analyse scenarios, make decisions and produce drawings and specifications to achieve appropriate, creative and innovative home design proposals.

Learning Outcomes

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

LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process

LO2 Explain the different types of construction information developed through the course of a project

LO3 Produce design propositions that address project requirements defined through feasibility stages

LO4 Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy.

Essential Content

LO1 **Discuss the stages of a design process and the types of information required to communicate, share and manage the project process**

Design criteria

Project type (e.g., residential, commercial, industrial, infrastructure)

Client type (e.g., private, institutional, public)

Environment/sustainability

Statutory requirements (e.g., planning permissions, health and safety, building regulations)

Project process

Feasibility

Design

Construction information

Site operations (e.g., variations/architect's instructions, on-site design)

Handover

Post-occupancy

Cost/fee information

Initial budget

Professional fees (e.g., architect/design fees, engineers' fees, project manager fees)

Construction costs (e.g., material costs, plant costs, labour costs)

Design process

Concept design

Design development

Detail design

Construction information

Construction information

Drawings (e.g., sketches, construction drawings, CAD)

Models (e.g., physical models, digital models, BIM data)

Specifications

Schedules

Information sharing

CAD formats

BIM data

Digital collaboration systems

LO2 **Explain the different types of construction information developed through the course of a project**

Construction drawings

Site drawings

General arrangement (GA) drawings

Consultant Information (e.g., structural, mechanical, environmental)

Details

Specifications

Preliminaries (‘prelims’)

Specification types (e.g., outline specification, performance specification)

Specification sections

Schedules

Door schedules

Window schedules

Fixtures/fittings schedules

Schedule of Works

Information coordination

Manual information coordination

Digital information coordination (e.g., BIM, single-model data)

Clash detection

Manual clash detection

Digital clash detection

Health and safety information

Pre-construction health and safety plan

Health and safety method statements

Risk assessments

Construction phase plans

Health and safety file

Material safety information (e.g., control of substances hazardous to health [COSHH], material handling guidelines)

LO3 **Produce design propositions that address project requirements defined through feasibility stages**

Feasibility

Client need

Site conditions (e.g., geotechnical, contamination, environmental impact)

Project type

Budget

Legal/statutory requirements

Design propositions

Initial/concept propositions

Design development

Design evaluation

Environmental evaluation

Design iteration

Construction information

Drawings

Specifications

Schedules

Health and safety information

LO4 **Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy**

Project roles/stakeholders

Client

User/occupier

Architects

Engineers (e.g., structural, mechanical)

Contractors (e.g., main contractor, sub-contractors)

Project managers

Contract managers

Cost consultants/quantity surveyors

Suppliers

Manufacturers

Project relationships

Contractual relationships

Professional collaboration (e.g., information sharing, information management)

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process</td><td rowspan="4">D1 Critically evaluate the relationship between design and project stages, highlighting the processes and procedures to ensure information coordination throughout.</td></tr>
<tr><td>P1 Describe the stages and activities of a construction design process.

P2 Explain the types of information required throughout the different stages of a project process.</td><td>M1 Assess the relationship between design and project stages and the information sharing requirements in each.</td></tr>
<tr><td colspan="2">LO2 Explain the different types of construction information developed through the course of a project</td></tr>
<tr><td>P3 Examine a brief to ascertain the requirements of a building project

P4 Outline the relationships between drawings, schedules and specifications.</td><td>M2 Analyse the importance of clash detection and information coordination.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Produce design propositions that address project requirements defined through feasibility stages		
P5 Create construction drawings and details using industry-standard tools and techniques. **P6** Produce specifications, schedules and an outline construction health and safety phase plan for a given project.	**M3** Prepare specification prelims and schedule of works, in coordination with construction drawings and details.	**D2** Evaluate a package of construction information, in relation to their coordination and accuracy.
LO4 Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy		
P7 Present construction information to an audience of specialists and non-specialists. **P8** Explain the coordination and information sharing between different roles and stakeholders in a construction project.	**M4** Analyse the ways in which different forms of contractual relationships between stakeholders influence flow of information in a construction project.	

Recommended Resources

Print resources

BELBIN, R. (2010), *Team Roles at Work*, Routledge

BUSSEY, P. (2019), CDM 2015: *A Practical Guide for Architects and Designers,* Routledge

CHING, F. (2011), *Building Construction Illustrated*, John Wiley & Sons

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), *Chudley and Greeno's Building Construction Handbook*, Butterworth-Heinemann

CONSTRUCTION SPECIFICATIONS INSTITUTE (2011), *The CSI Construction Specifications Practice Guide*, John Wiley & Sons

HUTH, M. (2018), *Understanding Construction Drawings*, Cengage Learning

KALIN, M., WEYGANT, R., ROSEN, H., REGENER, J. (2010), *Construction Specifications Writing: Principles and Procedures*, John Wiley & Sons

LAWSON, B. (2006), *How Designers Think: The Design Process Demystified*, Routledge

MAKSTUTIS, G. (2018), *Design Process in Architecture*, Laurence King Publishing

MEIER, H., WYATT, D. (2008), *Construction Specifications*, Delmar Pub

Web resources

https://www.architecture.com	**RIBA Plan of Work 2020** (Professional Body)
https://www.designingbuildings.co.uk	**Project plans for building design and construction** (Wiki)
https://www.cbuilde.com	**Chartered Association of Building Engineers** (Professional Body)
https://www.designingbuildings.co.uk	**Designing Buildings Wiki** (General Reference)
https://www.thenbs.com	**The NBS Knowledge** (General Reference)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 23: Construction Economics & Sustainability
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 39: Personal Professional Development
- Unit 47: Advanced Building Information Modelling
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction
- Unit 54: Advanced Quantity Surveying Practice.

Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)

Level: 4

Credits: 15

Ofqual Code: Y/651/2453

Introduction

The success of any project relies on the development of a good design and the technical information to allow the project to be built. The aim of this unit is to help students to appreciate and be aware of the design process and the information required to communicate the design itself, specify and quantify materials, provide instructions for the assembly and erection, and facilitate precise costing and project management.

Topics included in this unit are: project phases; construction drawing; detailing; Computer Aided Design (CAD); Building Information Modelling (BIM); schedules; specifications; bills of quantities; information collaboration.

On successful completion of the unit, students will be able to analyse scenarios, make decisions and produce drawings and specifications to achieve appropriate, creative and innovative home design proposals.

In particular, this unit complements the English Level 4 Civil Engineering Senior Technician occupational standard and alongside other key units provides comprehensive coverage of required Knowledge Skills and Behaviours.

Learning Outcomes

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

LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process

LO2 Explain the different types of construction information developed through the course of a project

LO3 Produce design propositions that address project requirements defined through feasibility stages

LO4 Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy.

Essential Content

LO1 **Discuss the stages of a design process and the types of information required to communicate, share and manage the project process**

Design criteria

Project type (e.g., residential, commercial, industrial, infrastructure)

Client type (e.g., private, institutional, public)

Environment/sustainability

Statutory requirements (e.g., planning permissions, health and safety, building regulations)

Project process

Feasibility

Design

Construction information

Site operations (e.g., variations, architect’s/engineer's instructions, on-site design)

Handover

Post-occupancy

Cost/fee information

Initial budget

Professional fees (e.g., architect/design fees, engineers’ fees,

Project manager fees)

Construction costs (e.g., material costs, plant costs, labour costs)

Design process

Concept design

Design development

Detail design

Construction information

Construction information

Drawings (e.g., sketches, construction drawings, CAD)

Models (e.g., physical models, digital models, BIM data)

Specifications

Schedules

Information sharing

CAD formats

BIM data

Digital collaboration systems

Data Security

LO2 **Explain the different types of construction information developed through the course of a project**

Construction Drawings

Site drawings

General arrangement (GA) drawings

Consultant Information (e.g., structural, mechanical, environmental)

Details

Specifications

Preliminaries (‘prelims’)

Specification types (e.g., outline specification, performance specification)

Specification sections

Schedules

Drawing schedules

Structural Beam schedules

Bar Bending schedules.

Schedule of Works

Information coordination

Manual information coordination

Digital information coordination (e.g., BIM, single-model data)

Clash detection

Manual clash detection

Digital clash detection

Health and safety information

Pre-construction health and safety plan

Health and safety method statements

Risk assessments

Construction phase plans

Health and safety file

Material safety information (e.g., control of substances hazardous to health [COSHH], material handling guidelines)

LO3 **Produce design propositions that address project requirements defined through feasibility stages**

Feasibility

Client need

Site conditions including –

- geotechnical (e.g., soil properties)
- hydraulics (e.g., fluid properties and behaviour)
- contamination (e.g., soil remediation)
- environmental strategy (e.g., materials selection and local supply)

Project type (buildings and infrastructure)

Budget

Legal/statutory requirements

Design propositions

Initial/concept propositions

Design development

Design evaluation

Environmental evaluation

Design iteration

Construction information:

Drawings

Specifications

Schedules

Health and safety information

LO4 **Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy**

Project roles/stakeholders

Client

User/occupier

Architects

Engineers (e.g., structural, mechanical)

Contractors (e.g., main contractor, sub-contractors)

Project managers

Contract managers

Cost consultants/quantity surveyors

Suppliers

Manufacturers

Project relationships

Contractual relationships

Professional collaboration (e.g., information sharing, information management, Data security)

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process</td><td rowspan="4">D1 Critically evaluate the relationship between design and project stages, highlighting the processes and procedures to ensure information coordination throughout.</td></tr>
<tr><td>P1 Describe the stages and activities of a construction design process.

P2 Explain the types of information required throughout the different stages of a project process.</td><td>M1 Assess the relationship between design and project stages and the information sharing requirements in each.</td></tr>
<tr><td colspan="2">LO2 Explain the different types of construction information developed through the course of a project</td></tr>
<tr><td>P3 Examine a brief to ascertain the requirements of a civil engineering project.

P4 Outline the relationships between drawings, schedules and specifications.</td><td>M2 Analyse the importance of clash detection and information coordination.</td></tr>
</table>

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO3 Produce design propositions that address project requirements defined through feasibility stages</td><td rowspan="4">D2 Evaluate a package of construction information, in relation to their coordination and accuracy.</td></tr>
<tr><td>P5 Create construction drawings and details using industry-standard tools and techniques.

P6 Produce specifications, schedules and an outline construction health and safety phase plan for a given project.

P7 Outline potential geotechnical, hydraulic, contamination and environmental problems for a given project</td><td>M3 Prepare specification prelims and schedule of works, in coordination with construction drawings and details.</td></tr>
<tr><td colspan="2">LO4 Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy</td></tr>
<tr><td>P8 Present construction information to an audience of specialists and non-specialists.

P9 Explain the coordination and information sharing between different roles and stakeholders in a construction project.</td><td>M4 Analyse the ways in which different forms of contractual relationships between stakeholders influence flow of information in a construction project.</td></tr>
</table>

Recommended Resources

Print Resources

BELBIN, R. (2010), Team Roles at Work, Routledge

BUSSEY, P. (2019), CDM 2015: A Practical Guide for Architects and Designers, Routledge

CHING, F. (2011), Building Construction Illustrated, John Wiley & Sons

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), Chudley and Greeno's Building Construction Handbook, Butterworth-Heinemann

CONSTRUCTION SPECIFICATIONS INSTITUTE (2011), The CSI Construction Specifications Practice Guide, John Wiley & Sons

DOUGLAS, J., GASIOREK, J., SWAFFIELD, J. (2001), Fluid Mechanics, Addison-Wesley Longman Limited

GRIBBLE, C., MCLEAN, A. (2017), Geology for Civil Engineers

HUTH, M. (2018), Understanding Construction Drawings, Cengage Learning

KALIN, M., WEYGANT, R., ROSEN, H., REGENER, J. (2010), Construction Specifications Writing: Principles and Procedures, John Wiley & Sons

LAWSON, B. (2006), How Designers Think: The Design Process Demystified, Routledge

MAKSTUTIS, G. (2018), Design Process in Architecture, Laurence King Publishing

MEIER, H., WYATT, D. (2008), Construction Specifications, Delmar Pub

Web resources

https://www.architecture.com	**RIBA Plan of Work 2020** (Professional Body)
https://www.designingbuildings.co.uk	**Project plans for building design and construction** (Wiki)
https://www.cbuilde.com	**Chartered Association of Building Engineers** (Professional Body)
https://www.designingbuildings.co.uk	**Institution of Civil Engineers Knowledge resources** (Professional Body)
https://www.thenbs.com	**The NBS Knowledge** (General Reference)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 21 Geotechnics & Soil Mechanics
- Unit 23: Construction Economics & Sustainability
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 39: Personal Professional Development
- Unit 42 Hydraulics
- Unit 47: Advanced Building Information Modelling
- Unit 53: Advanced Off-site Construction
- Unit 54: Advanced Quantity Surveying Practice

Unit 4001DB: Construction Design Project Design and Build Technician (Pearson-set)

Level: 4

Credits: 15

Ofqual Code: A/651/2454

Introduction

The success of any project relies on the development of a good design and the technical information to allow the project to be built. The aim of this unit is to help students to appreciate and be aware of the design process and the information required to communicate the design itself, specify and quantify materials, provide instructions for the assembly and erection, and facilitate precise costing and project management.

Topics included in this unit are: project phases; construction drawing; detailing; Computer Aided Design (CAD); Building Information Modelling (BIM); schedules; specifications; bills of quantities; information collaboration.

On successful completion of the unit, students will be able to analyse scenarios, make decisions and produce drawings and specifications to achieve appropriate, creative and innovative home design proposals.

In particular, this unit complements the English Level 4 Construction Design and Build Technician occupational standard and alongside other key units in the Construction suite provides comprehensive coverage of required Knowledge Skills and Behaviours.

Learning Outcomes

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

LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process

LO2 Explain the different types of construction information developed through the course of a project

LO3 Produce design propositions that address project requirements defined through feasibility stages

LO4 Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy.

Essential Content

LO1 **Discuss the stages of a design process and the types of information required to communicate, share and manage the project process**

Design criteria

Project type (e.g., residential, commercial, industrial, infrastructure, retrofit, historical renovation)

Procurement type (e.g. traditional, design and build, PFI framework agreement)

Client type (e.g., private, institutional, public)

Construction methods (e.g. historical, traditional, framed, Modern methods of construction etc.)

Environment/sustainability

Statutory requirements (e.g., planning permissions, building regulations, Historic England, health and safety, CDM 2015, HASAWA,)

Project process

Feasibility (e.g. site inspection processes, reporting techniques, etc.)

Design

Construction information

Site operations (e.g., variations/architect's instructions, on-site design)

Handover

Post-occupancy

Cost/fee information

Initial budget

Professional fees (e.g., architect/design fees, engineers' fees,

Project manager fees)

Construction costs (e.g., material costs, plant costs, labour costs)

Design process

Concept design

Design development

Detail design

Construction information

Construction information

Drawings (e.g., sketches, construction drawings, CAD)

Models (e.g., physical models, digital models, BIM data)

Specifications

Schedules

Information sharing

CAD formats

BIM data

Digital collaboration systems

Data security

LO2 **Explain the different types of construction information developed through the course of a project**

Construction Drawings

Site drawings

General arrangement (GA) drawings

Consultant Information (e.g., structural, mechanical, environmental)

Details

Specifications

Preliminaries (‘prelims’)

Specification types (e.g., outline specification, performance specification)

Specification sections

Schedules

Door schedules

Window schedules

Fixtures/fittings schedules

Schedule of Works

Information coordination

Manual information coordination

Digital information coordination (e.g., BIM, single-model data)

Clash detection

Manual clash detection

Digital clash detection

Health and safety information

Employee welfare management (e.g. managing stress, anxiety, depression etc)

Pre-construction health and safety plan

Health and safety method statements

Risk assessments

Construction phase plans

Health and safety file

Material safety information (e.g., control of substances hazardous to health[COSHH], material handling guidelines)

LO3 **Produce design propositions that address project requirements defined through feasibility stages**

Feasibility

Client need

Site conditions (e.g., geotechnical, contamination, environmental impact)

Project type

Retrofit (e.g., energy audits, structural integrity, existing services)

Budget (e.g. cost estimating, project budgets) Legal/statutory requirements

Design propositions

Initial/concept propositions

Design development

Sustainable development (e.g. construction techniques, MMC, energy optimisation etc.)

Low carbon and zero carbon energy sources (e.g. CHP, biomass GSHP, wind, solar PV, hydro etc.)

Building design optimisation (e.g., layout/orientation, maximise daylighting, solar gain, building space optimisation, prevent overheating, ventilation, passive and active design, etc.)

Application of mathematical techniques to solve problems. (e.g. insulation requirements, heat losses, lighting requirements, heating systems, energy optimisation, building design optimisation etc.)

Design evaluation techniques (e.g. simple cost-benefit analysis, cost savings, return periods, break-even analysis etc.)

Environmental evaluation

Design iteration

Construction information:

Drawings

Specifications

Schedules

Health and safety information

LO4 **Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy**

Project roles/stakeholders

Client

User/occupier

Architects

Engineers (e.g., structural, mechanical)

Contractors (e.g., main contractor, sub-contractors)

Project managers

Contract managers

Cost consultants/quantity surveyors

Suppliers

Manufacturers

Project relationships

Contractual relationships

Professional collaboration (e.g., information sharing, information management)

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process</td><td></td></tr>
<tr><td>P1 Describe the stages and activities of a construction design process.

P2 Explain the types of information required throughout the different stages of a project process.</td><td>M1 Assess the relationship between design and project stages and the information sharing requirements in each.</td><td rowspan="3">D1 Critically evaluate the relationship between design and project stages, highlighting the processes and procedures to ensure information coordination throughout.</td></tr>
<tr><td colspan="2">LO2 Explain the different types of construction information developed through the course of a project</td></tr>
<tr><td>P3 Examine a brief to ascertain the requirements of a building project.

P4 Outline the relationships between drawings, schedules and specifications.</td><td>M2 Analyse the importance of clash detection and information coordination.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Produce design propositions that address project requirements defined through feasibility stages		**D2** Evaluate a package of construction information in relation to their coordination and accuracy.
P5 Create construction drawings and details using industry-standard tools and techniques. **P6** Produce specifications, and schedules for an element of the design, using mathematical techniques to support your choices. **P7** Select appropriate sustainable energy solutions for a given project. **P8** Produce an outline construction health and safety phase plan for a given project.	**M3** Use mathematical techniques to assess the impact of the sustainable technologies used in the design. **M4** Prepare specification prelims and schedule of works, in coordination with construction drawings and details.	
LO4 Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy		
P9 Present construction information to an audience of specialists and non-specialists. **P10** Explain the coordination and information sharing between different roles and stakeholders in a construction project.	**M5** Analyse the ways in which different forms of contractual relationships between stakeholders influence flow of information in a construction project.	

Recommended Resources

Print Resources

BELBIN, R. (2010), *Team Roles at Work*, Routledge

BUSSEY, P. (2019), *CDM 2015: A Practical Guide for Architects and Designers*, Routledge

CHING, F. (2011), *Building Construction Illustrated*, John Wiley & Sons

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), *Chudley and Greeno's Building Construction Handbook*, Butterworth-Heinemann

CONSTRUCTION SPECIFICATIONS INSTITUTE (2011), *The CSI Construction Specifications Practice Guide*, John Wiley & Sons

HUTH, M. (2018), *Understanding Construction Drawings*, Cengage Learning

KALIN, M., WEYGANT, R., ROSEN, H., REGENER, J. (2010), *Construction Specifications Writing: Principles and Procedures*, John Wiley & Sons

LAWSON, B. (2006), *How Designers Think: The Design Process Demystified*, Routledge

MAKSTUTIS, G. (2018), *Design Process in Architecture*, Laurence King Publishing

MEIER, H., WYATT, D. (2008), *Construction Specifications*, Delmar Pub

Web resources

https://bit.ly/2WnuyCD	**RIBA Plan of Work 2020** (Professional Body)
https://bit.ly/3ld8PaW	**Project plans for building design and construction** (Wiki)
https://bit.ly/3rKsWPc	**Chartered Association of Building Engineers** (Professional Body)
https://bit.ly/2V1JwOr	**Designing Buildings Wiki** (General Reference)
www.thenbs.com	**The NBS Knowledge** (General Reference)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 23: Construction Economics & Sustainability
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 39: Personal Professional Development
- Unit 47: Advanced Building Information Modelling
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction
- Unit 54: Advanced Quantity Surveying Practice

Unit 2: Construction Technology

Level: 4

Credits: 15

Ofqual Code: J/618/8081

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 that facilitate enhanced environmental and energy performance, and greater flexibility. This is in response to ever-increasing financial, environmental, legal and economic constraints.

This unit introduces 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 that need to be borne in mind when selecting the most suitable technological solution.

Learning Outcomes

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

LO1 Explain the terminology used in construction technology

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

LO3 Discuss different methods of dealing with site conditions to support building and infrastructure construction

LO4 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 structures in the built environment

Building scale (e.g., low, medium, high-rise)

Domestic buildings (houses, flats, multi-occupancy)

Commercial buildings (e.g., offices, shops)

Industrial buildings (e.g., light industrial, warehouses factories).

Civil engineering structures (e.g., roads, highways, bridges, tunnels)

Structures

Loadbearing and non-loadbearing

Structural stability

Movement and thermal expansion

Construction methods

Timber frame

Steel frame

Masonry

Modern Methods of Construction (MMC) (e.g., offsite manufacture, panellised systems, volumetric/modular)

Materials

Types (e.g., timber, concrete, brick, steel)

Properties (e.g., durability, weather and moisture resistance, acoustics, thermal performance, fire resistance)

Environment

Insulation (e.g., fibreglass, solid panel, expanded foam, wool)

Heat loss and heat gain

Thermal transmission

Heating and cooling (e.g., passive, active)

Health and safety

Fire (e.g., fire resistance, flame spread, smoke, combustion)

Building regulations

Health and safety during construction

Construction information

Types of information (e.g., drawings, details, specification, schedules)

Information production (e.g., CAD, Building Information Modelling [BIM])

Sustainability

Scarcity and renewability

Supply chain

Lifecycle (e.g., 'Cradle-to-grave', 'Cradle-to-cradle', circular economies)

Professional bodies

Codes of practice

Codes of conduct

Professional ethics

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 research

Site reconnaissance

Soil investigation

Substructure design considerations

Soil type and content (e.g., water and chemical content, bearing capacity)

Position of trees

Economic considerations (e.g., cost of foundation type, labour, materials)

Legal considerations (e.g., health and safety, building regulations)

Plant requirements

Types of substructure

Shallow and deep foundations

Strip and deep strip foundations

Pad foundations

Raft foundations

Piled foundations (including replacement and displacement piles)

Superstructure design considerations

Form (e.g., building form, infrastructure form)

Building/infrastructure use

Aesthetics

Substructure type

Site access

Legal considerations (e.g., health and safety, building regulations)

Types of superstructure

Masonry (e.g., brick, block)

Framed construction (e.g., timber, steel, composite)

Reinforced concrete

Infrastructure types (e.g., roads, bridges, tunnels)

Walls

External walls (e.g., cavity wall, timber frame, lightweight steel)

Wall cladding (e.g., panel systems, infill systems, composite panel systems)

Internal partition walls (e.g., timber framed, steel framed, manufactured panels)

Roofs

Roof types (e.g., pitched, flat roof systems)

Roof construction (e.g., beams, rafters, fascia, battens)

Roof coverings

Floors

Floor type (e.g., ground floors, intermediate floors)

Floor construction (e.g., decking, subfloor, screed)

Floor finishes (e.g., timber, stone, sheet, poured)

Staircases

Staircase types (e.g., straight, dog-leg, circular, helical)

Stair construction (e.g., timber, concrete, metal)

Means of escape

Stair elements (e.g., tread, rise, stringer, nosing)

Finishes

Ceiling, wall, and floor finishes.

LO3 **Discuss different methods of dealing with site conditions to support building and infrastructure construction**

Site remediation

Contamination management (e.g., cut-off techniques, encapsulation)

Soil remediation (e.g., stone piling, vibro-compaction, phytoremediation)

De-watering

Piling (e.g., sheet piling, secant piling)

Concrete methods (e.g., diaphragm walls, coffer dams, caissons, culverts)

Grout injection

Freezing

Temporary techniques (e.g., pumping, wells, electro-osmosis)

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

Heating

Heat generators (e.g., boilers, solid fuel burners, combined heat and power plant)

Heating distribution (e.g., hot water, forced air, steam)

Heat delivery (e.g., radiators, fan coil units, air handling)

Ventilation

Mechanical (e.g., fans, pressure systems, vacuum systems, exhaust systems)

Natural (e.g., wind driven, stack ventilation, cross ventilation)

Air conditioning

Central air vs split system

Components (e.g., compressor, evaporator, cassette)

Services distribution

Hot and cold water

Single-phase and 3-phase electricity

Ventilation and air conditioning ductwork.

Services accommodation

Raised access flooring

Suspended ceilings

Partitioning

Rising ducts

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the terminology used in construction technology		
P1 Describe the differences between residential, commercial, industrial buildings and infrastructure projects. **P2** Discuss the ways in which sustainability can be promoted in construction projects.	**M1** Analyse the way that construction projects address risk and health and safety.	**D1** Compare the construction terminology used in different types of construction project.
LO2 Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria		
P3 Describe the pre-design studies carried out and types of information collected for a given construction site. **P4** Explain the functional characteristics and design criteria for primary and secondary elements of a substructure and superstructure.	**M2** Analyse how site conditions impact on the design of foundations.	**D2** Evaluate a given construction project with regard to the ways that superstructure, substructure and civil engineering structures are used to support the structure.
LO3 Discuss different methods of dealing with site conditions to support building and infrastructure construction		
P5 Describe techniques used for remediating the site prior to construction commencing. **P6** Describe the types of substructure works carried out by civil engineers.	**M3** Compare different types of structural frame used to carry the primary and secondary elements of the superstructure.	

Pass	Merit	Distinction
LO4 Illustrate the supply and distribution of a range of building services and how they are accommodated within the building		
P7 Describe the supply arrangements for primary services. **P8** Explain the distribution arrangements for primary services.	**M4** Demonstrate the elements of the superstructure used to facilitate the primary services.	**D3** Analyse the ways in which the distribution of the primary services impact on the overall design of the building.

Recommended Resources

Print resources

BRYAN, T. (2015), *Construction Technology*, John Wiley & Sons

CHARLETT, A., MAYBERY-THOMAS, C. (2013), *Fundamental Building Technology*, Routledge

CHUDLEY, R., GREENO, R. (2006), *Advanced Construction Technology*, Pearson Education

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), *Chudley and Greeno's Building Construction Handbook*, Butterworth-Heinemann

EMMITT, S. (2018), *Barry's Advanced Construction of Buildings*, John Wiley & Sons

FLEMING, E. (2009), *Construction Technology*, John Wiley & Sons

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

Links

This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 4: The Construction Environment
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 14: Principles of Refurbishment
- Unit 15: Principles of Alternative Energy
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 22: Scientific Principles for Building Services
- Unit 24: Principles of Off-site Construction
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 35: Sustainable Methods of Construction
- Unit 41: Highway Engineering
- Unit 44: Maintenance & Operations
- Unit 51: Advanced Construction Development & Prototyping
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction.

Unit 3: Science & Materials

Level: 4

Credits: 15

Ofqual Code: L/618/8082

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 in making 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. Students will consider health and safety alongside the need to meet legislative requirements.

The topics covered in this unit include: health and safety; storage and use of materials; handling and problems associated with misuse and unprotected use; environmental and sustainable consideration in material choices; 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.

On 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 and safety. Students will 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, students will be able to:

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

LO2 Discuss the environmental and sustainability factors that inform the material choices for a given construction project

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

LO4 Evaluate the performance of a given project in respect of its human comfort requirements.

Essential Content

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

Regulations and guidance

Health and safety management regulations

Construction 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 (e.g., moving materials safely, working in confined spaces, working at height)

Occupational health risks associated with materials (e.g., 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 that inform the material choices for a given 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 (CIRIA)

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

Material testing

Testing methods

Interpreting results of tested material data.

Codes and standards

Structural behaviours

Performance properties (e.g., 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 project in respect of its human comfort requirements**

Thermal

Heat loss

Heat gain

Thermal control (e.g., passive, active)

Illumination

Natural light

Artificial light

Heat gain through sunlight/exposure

Acoustics and vibration

Equipment noise/vibration (e.g., ventilation fans, air conditioning systems)

Road noise/vibration

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Review health and safety regulations and legislation associated with the storage, handling and use of materials on a construction site		
P1 Discuss the regulations associated with the storage, handling and use of materials. **P2** Describe strategies to safely manage the storage, handling and use of a selection of vocationally typical construction materials.	**M1** Analyse how risk assessments are used to address hazards posed by selected materials or activities.	**D1** Evaluate how multiple regulations and legislation may apply to a given site activity, highlighting how to plan and manage for safe handling and use of materials and processes.
LO2 Discuss the environmental and sustainability factors that inform the material choices for a given construction project		
P3 Explain material environmental profiling and lifecycle assessment, based on a material choice. **P4** Discuss the benefits of product declaration and environmental certification.	**M2** Produce a waste management plan for a given project, considering a typical range of relevant waste materials.	**D2** Illustrate how the use of sustainable practices and considerations for material choice can improve the environmental rating of the completed project.
LO3 Present material choices for a given project using performance properties, experimental data, sustainability and environmental consideration		
P5 Select construction materials for a given project based on testing results and their performance properties in use. **P6** Present the results of relevant testing procedures to identify performance characteristics of selected construction materials.	**M3** Assess the selection of structural materials, based on comparison of loading and performance and behaviour in alternative material choices.	

Pass	Merit	Distinction
LO4 Evaluate the performance of a given project in respect of its human comfort requirements		
P7 Define a material selection strategy with regard to human comfort requirements. **P8** Identify materials for a selected area within a project and explain how these contribute to human comfort.	**M4** Perform calculations (e.g., lux levels, u-values, acoustic performance, air changes) to support the provision of human comfort for a given project.	**D3** Evaluate how the use of passive or active strategies can minimise energy, materials, water and land use.

Recommended Resources

Print resources

BLANC, A. (1994), *Internal Components*, Longman Publishing Group

BUXTON, P. (2018), *Metric Handbook*, Routledge

CASINI, M. (2016), *Smart Buildings*, Woodhead Publishing

DEAN, Y. (2016), *Materials Technology*, Routledge

DORAN, D., CATHER, B. (2013), *Construction Materials Reference Book*, Routledge

EVERETT, A. (1994), *Mitchell's Materials*, Routledge

KHATIB, J. (2016), *Sustainability of Construction Materials*, Woodhead Publishing

LYONS, A. (2014), *Materials for Architects and Builders*, Routledge

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

SOMAYAJI, S. (2001), *Civil Engineering Materials*, Pearson College Division

THOMAS, R. (2006), *Environmental Design*, Taylor & Francis

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 14: Principles of Refurbishment
- Unit 15: Principles of Alternative Energy
- Unit 28: Group Project (Pearson-set)
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 35: Sustainable Methods of Construction
- Unit 36: Value Engineering & Cost Control
- Unit 45: Advanced Materials.

Unit 4: The Construction Environment

Level: 4

Credits: 15

Ofqual Code: R/618/8083

Introduction

Construction is a complex and dynamic sector of the local, regional, national and international economy. In many countries it is a driving force in the growth of finance, property and employment. This also means that it has considerable impact on many factors beyond its direct influence on the buildings and infrastructure that are created and maintained.

The construction industry is one of the major contributors to CO2 emissions. Also, the way that buildings are designed, constructed and maintained means they have an ongoing impact on the environment. Similarly, as a major employer, the industry has an ongoing impact on the working conditions of those in the sector and the way that people are educated, trained and supported through their careers.

In this unit, students will explore the make-up and the impact of the construction industry on the environment and society. By exploring the roles and relationships of individuals and organisations in the construction sector, students will gain an overview of the organisational and the personal ways in which the sector works to continue to improve the built environment and limit its impact on the environment, while maintaining economic sustainability and growth.

Learning Outcomes

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

LO1 Explore the development of the construction industry through the roles and relationships of the professionals involved

LO2 Assess the impact of the construction industry

LO3 Discuss the ways in which the construction industry ensures quality, timely completion and safety

LO4 Examine the routes to employment and progression within the construction industry.

Essential Content

LO1 **Explore the development of the construction industry through the roles and relationships of the professionals involved**

History of the industry

Roles

Architect

General contractor

Sub-contractor

Engineer (e.g., structural, civil, building services, traffic, fire)

Project manager

Quantity surveyor

Others

Collaboration

Relationships between organisations/roles

Individuals and collaboration

Collaboration through technology (e.g., project sharing, BIM, email)

Avoiding conflict in collaboration

Professional bodies

The purpose of professional bodies

Chartered Institute of Building (CIOB)

Chartered Institution of Building Service Engineers (CIBSE)

Chartered Association of Building Engineers (CABE)

Chartered Institute of Architectural Technologists (CIAT)

Institution of Civil Engineers (ICE)

Royal Institute of British Architects (RIBA)

Royal Institution of Chartered Surveyors (RICS)

Others

Codes of conduct

Professional ethics

LO2 **Assess the impact of the construction industry**

Construction and economy

Employment

Direct

Supply chain

Skills gaps

Construction and sustainability

Definitions of sustainability (e.g., environmental, social, economic, cultural)

Connections between forms of sustainability

Environmental sustainability

Carbon emissions

Carbon footprint

Embodied energy

Carbon reduction

Targets (government/global)

Environmental Strategies in Construction

Material selection

Local supply

Renewables

Energy

'Retrofit First'

Diversity and inclusion

The current state of the industry (e.g., gender representation, minority representation, 'an aging industry')

Promoting diversity and inclusion (e.g., benefits, challenges)

Equality and diversity legislation

Organisation for equality and diversity (e.g., professional bodies, Women into Construction, GoConstruct)

LO3 **Discuss the ways in which the construction industry ensures quality, timely completion and safety**

History of safety in construction

Pre-regulations

Post-regulations

Ensuring safety

Safety pre-construction (e.g., design and planning, building regulations)

Site safety (e.g., legislation, regulations)

Safety in use

Cost control and cost monitoring

Material costs

Plant costs (e.g., purchase, lease)

Labour costs (e.g., direct labour, subcontractors)

Cost overrun (e.g., caused by defects, caused by changes, caused by weather)

Contracts, safety and quality, safety and quality

Types of contract relationship (e.g., services contracts, works contracts)

Contract requirements (e.g., time, cost, quality)

Contracts and statutory requirements

Timely completion and quality

Quality and value (e.g., defining value, increasing value, increasing safety)

Project 'sign-off' and quality (e.g., documenting completion of work, certifying safe work, hand-over of relevant information)

Professional standards and professional bodies

LO4 **Examine the routes to employment and progression within the construction industry**

Technical skills

Employability skills

Communication

Collaboration

Resilience

Adaptability

Independence

Stages of employment

Professional bodies

Technician

Chartered

Fellow

Progressing in employment

Education and training

Continuing Professional Development

Personal development plans

Lifelong learning

Leadership and management

Developing as a manager

Leadership skills

Supporting the development of others

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore the development of the construction industry through the roles and relationships of the professionals involved		
P1 Discuss the development of the construction industry using historic and contemporary examples. **P2** Explain the roles and responsibilities of those that work in the construction industry.	**M1** Analyse the purpose of professional bodies in supporting the industry and protecting the public.	**D1** Evaluate the ways in which professionalism, diversity and inclusion are important to the growth of the construction sector.
LO2 Assess the impact of the construction industry		
P3 Explain the different types of sustainability and how the construction industry is reflected in these. **P4** Define potential strategies to promote equality, diversity and inclusion and ensure fairness at work.	**M2** Illustrate the challenges of the construction industry in regard to diversity and inclusion.	
LO3 Discuss the ways in which the construction industry ensures quality, timely completion and safety		
P5 Discuss the processes and requirements for project handover, ensuring the safety and quality of work. **P6** Explain the importance of monitoring costs in construction projects.	**M3** Analyse the ways in which legislation and regulation work to ensure safety during construction and occupation.	**D2** Critically analyse the role of professional bodies in supporting quality and safety in construction.

Pass	Merit	Distinction
LO4 Examine the routes to employment and progression within the construction industry		
P7 Prepare a personal development plan, highlighting routes to achieve subject relevant technical and employability skills. **P8** Examine the role of professional bodies and routes into employment.	**M4** Assess the ways in which CPD and lifelong learning support employment progression.	**D3** Evaluate the ways in which education, training and CPD are used to build leadership and management capacity in construction organisations.

Recommended Resources

Print resources

FEWINGS, P. (2008), *Ethics for the Built Environment*, Routledge

GRUNEBERG, S., FRANCIS, N. (2019), *The Economics of Construction*, *Economics of Big Business*

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

MIRSKY, R., SCHAUFELBERGER, J. (2014), *Professional Ethics for the Construction Industry*, Routledge

MURRAY, M., DAINTY, A., MURRAY, M. (2008), *Corporate Social Responsibility in the Construction Industry*, Routledge

SCHLEIFER, T. (1990), *Construction Contractors' Survival Guide*, John Wiley & Sons

Web resources

https://www.cbuilde.com	**Chartered Association of Building Engineers** (Professional Body)
https://www.ciat.org.uk	**Chartered Institute of Architectural Technologists** (Professional Body)
https://www.cibse.org	**Chartered Institution of Building Services Engineers** (Professional Body)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)
https://www.architecture.com	**Royal Institute of British Architects** (Professional Body)
https://www.rics.org	**Royal Institution of Chartered Surveyors** (Professional Body)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 20: Site Supervision & Operations
- Unit 25: Quantity Surveying Practice
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 39: Personal Professional Development
- Unit 54: Advanced Quantity Surveying Practice.

Unit 5: Legal and Statutory Requirements in Construction

Level: 4

Credits: 15

Ofqual Code: Y/618/8084

Introduction

The construction industry is perceived to be a dangerous, noisy and disruptive area of work that 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 introduces 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. Students 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.

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, students will be able to:

LO1 Explain the process used to obtain planning permission for the construction and alteration of buildings

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

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

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

Essential Content

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

Purpose of planning regulations

Development control

Environmental protection

Land use

Gaining planning permission

The legal framework (e.g., legislation, regulatory)

Types of development

Permitted development

Application process (e.g., application forms, statutory and public notification)

Approval process and conditions.

Appealing planning decisions

The right of appeal (e.g., applicants, general public, timeframes)

Appeal processes (e.g., forms, procedures, 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/building regulation systems

History and development

Legislation

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

Building regulations and health and safety

Safety in construction

Safety in operation and occupation

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

Health and safety

Legislation

Documentation

Enforcement

Liability

Occupiers' liability (e.g., duty of care, breach of duty, damage, defences, dangerous premises, visitors, children, independent contractors, trespassers and non-visitors, case law and legislation)

Vicarious liability (e.g., definitions of employer and employee, application of the course of employment rule, independent contractors, general principles, non-delegable duties)

Trespass to land

Forms of trespass (e.g., intrusion, possession)

Defence and remedy (including damages, injunction and ejectment)

The operation of the construction industry and trespass

Mitigating measures (e.g., Considerate Contractors Scheme)

Nuisance

Private nuisance (e.g., encroachment, interference, unlawfulness, impact of continuity, sensitivity and locality, liability, damage, defences and remedies)

Public nuisance (e.g., obstruction, pollution, criminal offence, mitigation)

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 (e.g., freehold, leasehold)

Tenure restrictions on ownership (e.g., restrictive covenants, easements)

Law of contract and property conveyancing

Key stages in the law of contract (e.g., offer, intention, capacity, consideration)

The stages and requirements of the property conveyancing process

Landlord and tenant law

Legislation

Types of lease (e.g., residential, commercial)

Lease terms and conditions

Rent and repair responsibilities

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 (e.g., party walls, party structures, boundary conditions, 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
LO1 Explain the process used to obtain planning permission for the construction and alteration of buildings		**D1** Evaluate the impact of planning systems and building regulations agencies on managing the development of land, buildings and structures.
P1 Describe the key legislation and agencies involved in the planning process. **P2** Discuss how planning decisions are made and processes available to appeal and monitor.	**M1** Analyse the role of planning systems and agencies in managing the development of land, buildings and structures.	
LO2 Discuss the processes and regulations used to control design and to ensure safe buildings		
P3 Explain the key legislation and agencies involved in the building control process. **P4** Explore the processes for monitoring and appealing building control decisions.	**M2** Analyse the differences in building regulations, related to safety, applicable low- and medium-rise buildings.	
LO3 Assess the laws used to ensure that construction sites operate safely and consider adjoining land-users		**D2** Produce a detailed plan for a contractor to reduce the legal impacts of a large urban construction project.
P5 Explain how the law of trespass and nuisance relate to the construction industry. **P6** Discuss how liability law applies to the construction industry.	**M3** Analyse legislation related to safe operation of construction sites.	
LO4 Analyse how the law of contract and land law are used to sell and lease land and buildings		**D3** Evaluate the impact of land law and property law on the development, sale and tenanting of a large urban construction project.
P7 Analyse how land law has evolved to shape modern land ownership and the role of contract law in buying and selling property. **P8** Discuss how landlord and tenant law is used to manage a given property.	**M4** Assess the application of land law and landlord and tenant law control the disposal and use of a given property.	

Recommended Resources

Print resources

CARD, R., MURDOCH, J., MURDOCH, S. (2003), *Estate Management Law*, LexisNexis

CLOUGH, R., SEARS, G., SEARS, S., SEGNER, R., ROUNDS, J. (2015), *Construction Contracting*, John Wiley & Sons

JOWSEY, E. (2014), *Real Estate Concepts*, Routledge

MASON, J. (2016), *Construction Law*, Routledge

MASON, J. (2021), *Innovating Construction Law*, Routledge

UFF, J. (2017), *Construction Law*, Sweet & Maxwell

Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 20: Site Supervision & Operations
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 35: Sustainable Methods of Construction
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.

Unit 6: Digital Applications for Construction Information

Level: 4

Credits: 15

Ofqual Code: D/618/8085

Introduction

Achieving 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 allow for accurate costing and management. Throughout the process of design, construction and post-occupancy management, information is critical.

Central to construction information is the production of construction drawings. These provide the geometric definition of a project through the use of graphic conventions. Most other forms of construction information will rely, to a greater or lesser degree, on reference to construction drawings. Therefore, the production of accurate and clearly defined construction drawings is a critical part of the overall construction information package.

Digital applications play a key role in the production of construction drawings. They provide a way to manage drawing information and make changes with greater efficiency and can be shared readily through a variety of digital communication systems.

In this unit students will develop the skills to needed produce accurate and consistent construction information using industry-standard software. On completion of the unit, students will be able to produce a construction information package. Successful achievement of the unit, may also lead to vendor certification.

Learning Outcomes

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

LO1 Discuss the key types of construction information that may be produced in support of construction projects

LO2 Demonstrate the use of project standards and their setup in digital applications

LO3 Generate construction information for a given project using industry-standard digital applications

LO4 Present a package of construction information, including drawings, schedules and specifications for a given construction project.

Essential Content

LO1 **Discuss the key types of construction information that may be produced in support of construction projects**

Pre-design information

Survey information (e.g., site survey, building survey)

Surveying existing buildings

Client requirements (e.g., client brief, existing documents)

Construction drawings

Plans (e.g., floor plans, ceiling plans, site plans, roof plans, electrical plans, HVAC plans)

Sections (e.g., building sections, wall sections)

Elevations (e.g., interior elevations, exterior elevations)

Details (e.g., construction details, assembly details)

Schedules

Door schedules

Window schedules

Finish schedules

Other

Specifications

Performance specification

Outline specification

Full specification

Specification templates/standards

Relationship with other forms of construction information

Contracts and associated costing

3D models

Building Information Modelling (BIM)

Project and site management (e.g., programmes of work, schedule of work, reporting of progress)

Information collaboration

Working with other professionals

Individual production vs team production

Integrating information from others

LO2 **Demonstrate the use of project standards and their setup in digital applications**

Project standards

Managing consistency in information

Ensuring quality in construction

Graphic standards

Line types (e.g., solid lines, dotted lines, centre lines)

Line weights

Line colours

Hatching types

Industry-defined graphic standards

Layer settings

Information standards

Sheet templates (e.g., title blocks, sheet layout)

Drawing symbols (e.g., drawing titles, section markers, elevation markers)

Reusable objects

Graphic objects (e.g., furniture, fittings, symbols)

Standard details

LO3 **Generate construction information for a given project using industry-standard digital applications**

Drawing objects

Lines and polylines

Rectangles and polygons

Circles and arcs

Drawing accuracy

Grid snapping

Object snapping

Coordinate systems

Drawing modification

Move and copy objects

Rotate and scale objects

Duplication and arrays (e.g., linear arrays, polar arrays)

Trimming

Extending (e.g., extend to object, extend to boundary extend to intersection)

Mirroring objects

Object editing (e.g., using ‘handles’ to modify lines, rectangles, polygons, polylines)

Fillets and chamfering

Fills and hatching

Solid fills

Pattern fills

Hatching (e.g., material hatching, pattern hatching)

Drawing layers

Using layers to relate to separate construction elements

Layer-specific settings (e.g., line weights, colours)

Layer visibility

Moving objects between layers

Annotation and dimensions

Dimensions (e.g., positioning, terminators, font size and style)

Annotations (e.g., notes, leader lines, arrows, font size and style, position, section markers, detail bubbles)

LO4 **Present a package of construction information, including drawings, schedules and specifications for a given construction project**

Standard sheets

DIN formats (e.g., A4, A3, A2, A1)

Imperial formats (e.g., 18´ 24, 24´ 36, 36´ 48)

Sheet templates

Title blocks

Sheet numbering

Project information

Creating sheet views

Sheet view and scale

Placing sheet views

Coordinating layer visibility with output

Printing and non-printing layers

Layer-defined properties

Schedules

Including schedules in drawings

Schedules as separate documents

Specifications

Document format

Specification standards (e.g., NBS, MasterSpec)

References (e.g., to drawings/schedules, from drawings/schedules)

Output standards

Printing setup

Plotting setup

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the key types of construction information that may be produced in support of construction projects		**D1** Evaluate the use of project standards in the development of consistent construction drawings for different projects.
P1 Explain the different types of construction information that are required for a given project. **P2** Describe the relationship between construction drawings and other forms of construction information, and their potential impact on project costs.	**M1** Compare the use of digital applications with other forms of construction drawing production in terms of efficiency and accuracy.	
LO2 Demonstrate the use of project standards and their setup in digital applications		
P3 Setup project standards in an industry-standard digital application for a given construction project. **P4** Define drawing symbols and reusable objects for a given construction project.	**M2** Use layer settings to define consistent line styles, colours and weights for construction drawings.	

Pass	Merit	Distinction
LO3 Generate construction information for a given project using industry-standard digital applications		**D2** Justify the approach to producing construction information for a given project, highlighting examples of good practice in the use of industry-standard digital applications.
P5 Create plans, sections, elevations and details for given a construction project, using industry-standard digital software. **P6** Integrate dimensions, annotations and appropriate hatching for construction drawings of a given project.	**M3** Demonstrate the use of modification tools to assist in the development of accurate construction drawings.	
LO4 Present a package of construction information, including drawings, schedules and specifications for a given construction project		
P7 Output construction drawings, to scale, on industry-standard sheet sizes for a given project. **P8** Coordinate information; both paper-based and digital, presented in schedules and specifications with construction drawings.	**M4** Manage the use of printing and non-printing layers to develop coherent construction information output.	

Recommended Resources

Print resources

AOUAD, G., WU, S., LEE, A., ONYENOBI, T. (2013), *Computer Aided Design Guide for Architecture, Engineering and Construction*, Routledge

BALLAST, D. (2009), *Architect's Handbook of Construction Detailing*, John Wiley & Sons

BEST, R., VALENCE, G. (2007), *Design and Construction*, Routledge

CHING, F. (2011), *Building Construction Illustrated*, John Wiley & Sons

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), *Chudley and Greeno's Building Construction Handbook*, Butterworth-Heinemann

CONSTRUCTION SPECIFICATIONS INSTITUTE (2011), *The CSI Construction Specifications Practice Guide*, John Wiley & Sons

HUTH, M. (2018), *Understanding Construction Drawings*, Cengage Learning

KALIN, M., WEYGANT, R., ROSEN, H., REGENER, J. (2010), *Construction Specifications Writing: Principles and Procedures*, John Wiley & Sons

KUBBA, S. (2008), *Blueprint Reading*, McGraw Hill Professional

Web resources

https://www.designingbuildings.co.uk	**Designing Buildings Wiki** (General Reference)
https://www.thenbs.com	**The NBS Knowledge** (General Reference)
https://www.autodesk.com	**Autodesk University** (Training)
https://www.csiresources.org	**CSI** (General Reference)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 7: Surveying, Measuring & Setting-out
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 47: Advanced Building Information Modelling.

Unit 7: Surveying, Measuring & Setting-out

Level: 4

Credits: 15

Ofqual Code: H/618/8086

Introduction

Surveying is an essential function in the construction industry, providing services throughout a project's lifecycle. It begins with collections of initial data on which to base design, then moves on to positional control of the construction process and finally records the 'as built' position for comparison with design. There is also a need for monitoring of adverse effects to the surrounding environment. The aspect that binds all of these functions is the control network, which forms the basis for all measurements, and this is a continuous thread throughout the unit.

In practice, surveying functions are divided between the 'Land Surveyor' to establish the positional reference and provide topographic data, and the 'Civil Engineer' to provide control of construction (setting out) and monitoring. Since there is dependence and commonality between them, this unit covers both contexts equally.

In this unit, students will explore the techniques used to set up controls and conduct initial surveys, including communication of results and methods of setting out the built environment. Students will be able to identify and analyse the sources of error and mitigation techniques used in common aspects of surveying.

Learning Outcomes

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

LO1 Explain the methods and technologies used in surveying for construction

LO2 Undertake a closed levelling and stages of a closed 2D traverse survey to establish station coordinates for horizontal and vertical control

LO3 Apply industry-standard techniques in the collection of survey data and setting out the coordinates of construction elements

LO4 Explore the causes of errors and techniques to improve accuracy in surveying and setting out.

Essential Content

LO1 **Explain the methods and technologies used in surveying for construction**

Applications of surveying in construction

Topographic (e.g., green field, brown field, green belt)

Cut and fill survey

Control of construction

Monitoring construction

As-built

Current and emerging technologies

Total station

GPS (Global Positioning System) and GNSS (Global Navigation Satellite System)

LiDAR (Light Detection and Ranging)

Drones/UAV (Unmanned Aerial Vehicles)

Laser scanning

Mobile 3D mapping

Photogrammetry

Survey outputs

2D drawings

3D data

Point cloud

Coding conventions

Graphic symbols

Vector outputs

File formats

LO2 Undertake a closed levelling and stages of a closed 2D traverse survey to establish station coordinates for horizontal and vertical control

Types of control points and control networks

First order

Second order

Local and national grid coordinate systems

Types of traverse

Open traverse

Closed traverse

Methods of traverse

Standard methods of horizontal angle and electronic distance measurement

Physical positioning of instruments and targets

Plane table traversing (2D)

Levelling for height

Calculating accuracy of levelling and traverse observations

Calculations to obtain coordinates

Control station accuracy and national/industry standards

Health and safety in surveying and setting out

Assessing site conditions

Existing structures and safety

Working at height

Personal positioning

Working near machinery and mobile plant

LO3 **Apply industry-standard techniques in the collection of survey data and setting out the coordinates of construction elements**

Holistic view of topographic surveying and setting out

Terminology

Referencing control in data collection and setting out

Topographic and construction elements

Buildings and walls, outlines – footprint

Centre lines of structural elements

Boundary locations from national co-ordinates

Road centre lines – kerbs and street furniture

Drainage – utility covers

Hard and soft landscape features

Ground levels, bank tops and bottoms

Positioning and orientating a total station

Free station

Known back sight

Resection

Set orientation

Redundancy and checking

Setting-out and data collection techniques

Obtaining and transferring topographic and setting-out data

Recording topographic detail

Setting-out structures and offsetting lines of structural elements

Horizontal and vertical control of construction

Determining accuracy in setting out

Comparing setting out accuracy with national/industry standards

LO4 **Explore the causes of errors and techniques to improve accuracy in surveying and setting out**

Errors in surveying and setting out

Collimation error in the horizontal plane

Instrumentation error (e.g., prism constants, reflector heights, atmospheric influences, calibration certification, setup errors, discrete setting out)

Observation error (e.g., two-face observation, pointing and focus, horizontal and vertical collimation)

Human errors (e.g., 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

Using national/industry standards to determine accuracy

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explain the methods and technologies used in surveying for construction</td><td rowspan="4">D1 Evaluate the accuracy that may be achieved in a closed traverse survey using different methods and technologies.</td></tr>
<tr><td>P1 Describe the different types of surveying and their uses for construction.

P2 Explain the technologies used in surveying for construction.</td><td>M1 Analyse the potential benefits of using different technologies in surveying.</td></tr>
<tr><td colspan="2">LO2 Undertake a closed levelling and stages of a closed 2D traverse survey to establish station coordinates for horizontal and vertical control</td></tr>
<tr><td>P3 Conduct a closed levelling to establish height control.

P4 Carry out stages of a closed 2D traverse to establish horizontal control.</td><td>M2 Calculate coordinates and heights of control stations from field observations.</td></tr>
<tr><td colspan="2">LO3 Apply industry-standard techniques in the collection of survey data and setting out the coordinates of construction elements</td><td rowspan="4">D2 Use industry-standard techniques, including software/technology, to improve the accuracy of survey and setting-out data.</td></tr>
<tr><td>P5 Collect topographic detail using point and line codes.

P6 Undertake setting-out operations for construction elements.</td><td>M3 Analyse the accuracy achieved in setting-out and data collection activities.</td></tr>
<tr><td colspan="2">LO4 Explore the causes of errors and techniques to improve accuracy in surveying and setting out</td></tr>
<tr><td>P7 Explain the common causes of errors in setting out and surveying.

P8 Compare the accuracy of setting out data to national/industry standards.</td><td>M4 Assess the impact of surveying and setting-out errors for construction projects.</td></tr>
</table>

Recommended Resources

Print resources

IRVINE, W., MACLENNAN, F. (2006), *Surveying for Construction*, McGraw-Hill

SADGROVE, B., DANSON, E. (2007), *Setting-out Procedures for the Modern Built Environment*, Ciria

SCHOFIELD, W., BREACH, M. (2007), *Engineering Surveying, Sixth Edition*, CRC Press

UREN, J., PRICE, W. (2010), *Surveying for Engineers*, Palgrave Macmillan

Web resources

https://www.cices.org	**Chartered Association of Civil Engineering Surveyors** (Professional Body)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)
https://www.tsa-uk.org.uk	**The Survey Association** (Professional Body)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 17: Civil Engineering Technology
- Unit 23: Construction Economics & Sustainability
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling.

Unit 8: Mathematics for Construction

Level: 4

Credits: 15

Ofqual Code: K/618/8087

Introduction

The aim of this unit is to develop students' knowledge and understanding of the mathematical principles and theories that underpin many aspects of construction technology, structures and materials. Students will be introduced to mathematical methods and statistical techniques so that they can analyse and solve problems in 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 in 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, students will be able to:

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

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

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

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

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 × 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

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
LO1 Use analytical and computational methods to solve construction-related problems		
P1 Solve construction problems using trigonometry techniques. **P2** Solve construction problems using algebraic techniques.	**M1** Apply the use of matrices to solve problems.	**D1** Evaluate analytical and statistical findings from construction problems completed and justify the techniques adopted to solve such problems.
LO2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages		
P3 Apply statistical methods, including the calculation of the mean and standard deviation, to produce accurate and appropriate solutions to construction engineering problems. **P4** Calculate probabilities within both binomially distributed and normally distributed random variables.	**M2** Interpret the results of a statistical hypothesis test conducted from a given scenario.	
LO3 Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus		
P5 Use differential calculus techniques to solve functions which incorporate: axn, sine ax, cosine ax, loge x, eax and methods including function of a function. **P6** Use integral calculus techniques to determine indefinite and definite integrals of functions involving axn, sine ax, cosine ax, 1/x and eax.	**M3** Apply the rules of integral calculus to determine solutions for complex construction-related problems.	**D2** Analyse differential calculus techniques in the determination of maxima and minima in construction-related problems.

Pass	Merit	Distinction
LO4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems		
P7 Apply dimensional analysis to solve problems. **P8** Generalise answers from a contextualised arithmetic progression problems.	**M4** Solve construction problems using vector analysis.	**D3** Evaluate the effectiveness and relevance, to the solving of complex construction problems, of the mathematical technique of vector analysis.

Recommended Resources

Print resources

LEVY, S. (2011), *Construction Calculations Manual*, Butterworth-Heinemann

SINGH, K. (2011), *Engineering Mathematics Through Applications*, Macmillan International Higher Education

STROUD, K., BOOTH, D. (2001), *Engineering Mathematics*, Industrial Press Inc.

VIRDI, S., BAKER, R., VIRDI, N. (2014), *Construction Mathematics*, Routledge

Links

This unit links to the following related units:

- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 16: Principles of Public Health Engineering
- Unit 17: Civil Engineering Technology
- Unit 18: Principles of Electrical Design & Installation
- Unit 19: Principles of Structural Design
- Unit 31: Advanced Structural Design
- Unit 34: Further Mathematics for Construction
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 42: Hydraulics
- Unit 49: Advanced Electrical Design & Installation.

Unit 9: Principles of Heating, Ventilation and Air Conditioning

Level: 4

Credits: 15

Ofqual Code: M/618/8088

Introduction

The buildings we use in everyday life – to work, study, socialise and live in – can be increasingly complex in their design, as well as being subject to more stringent environmental targets for emissions. The heating, ventilation and air conditioning systems in buildings play a major role in maintaining the comfort of the occupants and managing environmental impact.

This unit introduces students to the principles of the design and installation of heating, ventilation and air conditioning systems for non-domestic buildings.

In this unit, students will develop an understanding of the components and systems that may be integrated into a building services installation, including key calculations, sizing and specification of non-domestic heating, ventilation and air conditioning systems and components.

Learning Outcomes

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

LO1 Prepare the pre-design information required for a non-domestic heating, ventilation and air conditioning installation

LO2 Analyse the heating and cooling loads for a non-domestic building

LO3 Present a design proposal for a heating, ventilation and air conditioning system for a given non-domestic building type

LO4 Justify the selection of non-domestic heating, ventilation and air conditioning system components for a proposed installation.

Essential Content

LO1 **Prepare the pre-design information required for a non-domestic heating, ventilation and air conditioning installation**

The design process

Design stages and tasks

Legislation and regulation (e.g., building regulations, professional bodies, codes of practice)

Health and safety

Design constraints

Risk assessment

Pre-design/design brief

Building form

Building orientation

Air tightness

Fabric insulation

Glazing

Thermal mass

Occupancy, usage details

Potential internal loads

Budget

Cost plan

Health and safety risk assessment

Design data

External design data

Internal design condition

Design standards and statutory requirements

Publications and guides

Contracts

Consultancy

Sub-contract

Management

Installation

Maintenance

Sustainability

Existing energy use

Potential of passive systems (e.g., solar gain, passive ventilation)

Building fabric modifications (e.g., improved glazing systems, insulation)

LO2 **Analyse the heating and cooling loads for a non-domestic building**

U-values

Calculation of U-values for composite structures

Heat loss

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

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 proposal for a heating, ventilation and air conditioning system for a given non-domestic 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 (e.g., low pressure hot water (lphw), medium pressure hot water (mphw), high pressure hot water (hphw), 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

Air and dirt separators

Pipework expansion devices

Regulating valves

Fire collars

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 (e.g., direct expansion (DX), chilled water)

Centralised and local plant selection

Air conditioning systems (e.g., 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 heating, ventilation and air conditioning system components for a proposed installation**

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

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

Sustainability

Energy use

Use of passive systems

Overall strategy (e.g., building fabric, insulation, HVAC solution)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Prepare the pre-design information required for a non-domestic heating, ventilation and air conditioning installation		
P1 Explain the design process stages and tasks for a non-domestic heating, ventilation and air conditioning installation. **P2** Produce design data for a heating, ventilation and air conditioning installation for a given non-domestic building. **P3** Prepare a health and safety risk assessment for a non-domestic heating, ventilation and air conditioning installation.	**M1** Analyse human comfort requirements to support a proposed non-domestic heating, ventilation and air conditioning installation.	**D1** Evaluate the health and safety and environmental legislation relevant to the design and operation of a non-domestic heating, ventilation and air conditioning installation.
LO2 Analyse the heating and cooling loads for a non-domestic building		
P4 Undertake calculations to establish u-values, heat loss and total heat/cooling loads for a given non-domestic building. **P5** Compare the impact of changes to materials on calculation of u-values, heat loss and heating/cooling loads for a given non-domestic building.	**M2** Assess the current requirements for minimum u-values in domestic and non-domestic buildings.	

Pass	Merit	Distinction
LO3 Present a design proposal for a heating, ventilation and air conditioning system for a given non-domestic building type		**D2** Evaluate options for a non-domestic heating, ventilation and air conditioning installation to improve sustainability in a given project.
P6 Discuss suitable alternative heating, ventilation and air conditioning strategies for a given non-domestic building type. **P7** Present a design proposal for a non-domestic heating, ventilation and air conditioning installation.	**M3** Analyse the performance of selected components of a heating, ventilation, and air conditioning installation.	
LO4 Justify the selection of non-domestic heating, ventilation and air conditioning system components for a proposed installation		
P8 Calculate sizes of pipework and ducting for a proposed heating, ventilation and air conditioning installation. **P9** Discuss how selected heating, ventilation and air conditioning components meet the requirements of the given building.	**M4** Discuss how the selection of different components impacts on an installation strategy.	

Recommended Resources

Print resources

AL-SHEMMERI, T., PACKER, N. (2021), *Building Services Engineering*, John Wiley & Sons

BUTCHER, K. (2005), *Heating, Ventilating, Air Conditioning and Refrigeration*, Chartered Institution of Building Services Engineers.

CHADDERTON, D. (2014), *Air Conditioning*, Routledge

CHADDERTON, D. (2004), *Building Services Engineering*, Routledge

CIBSE (2006), *Environmental Design*, CIBSE

PORTMAN, J. (2016), *Building Services Engineering*, John Wiley & Sons

WATKINS, D. (2011), *Heating Services in Buildings*, John Wiley & Sons

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 8: Mathematics for Construction
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 34: Further Mathematics for Construction
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 42: Hydraulics
- Unit 48: Thermofluids & Acoustics
- Unit 49: Advanced Electrical Design & Installation.

Unit 10: Measurement & Estimating

Level: **4**

Credits: **15**

Ofqual Code: **T/618/8089**

Introduction

The techniques explored in 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 is essential for the quantity surveyor and estimator.

The overall aim of this unit is to give students 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 in this unit are: estimating techniques; standard methods of measurement; taking-off dimensions; preparation of bills of quantities; estimating data collection; 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. Students will have the fundamental knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

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

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

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

LO4 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 metre and cubic metre estimates

Elemental estimating

Approximate quantities techniques

Measurement using dimension paper

Measurement using software packages

Standard methods of measurement for taking-off quantities

Construction and Building Services (e.g., New Rules of Measurement (NRM), NRM 1 – quantification of building works for the purpose of preparing cost estimates and cost plans, NRM 2 – preparation of bills of quantities and quantified schedules of works, NRM 3 – quantification and description of maintenance works)

Civil Engineering (e.g., Civil Engineering Standard Method of Measurement 4 (CESMM4) – procedure for the preparation of a bill of quantities)

International Construction Measurement Standards (ICMS)

International Property Measurement Standards (IPMS)

Standard Method of Measurement (e.g., (Legacy) SMM7 – detailed information, classification tables and rules for measuring building works)

Coding schemes

Measurement rules

Dimension sheets

Project stages

Client's budget setting

Preliminary stages

Project comparison stages

Final design stage

Preparation of bills of quantities for the tendering for work (e.g., 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

Traditional (using dimension paper)

Abstraction of quantities

Associated working up processes

Preparation of bill of quantities pages

Computer aided systems

Use of digitisers

Building Information Modelling (BIM)

Taking-off

Facilitating works (e.g., toxic/hazardous/contaminated material removal, major demolition works, temporary support to adjacent structures, specialist groundworks, temporary diversion works, extraordinary site investigation works)

Substructure (e.g., excavation works, standard foundations, specialist foundations, lowest floor construction, basement excavation and retaining walls)

Superstructure (e.g., frame, upper floors, roof, stairs and ramps, external walls, windows and external doors, internal walls and partitions, internal doors)

Internal finishes (e.g., wall finishes, floor finishes, ceiling finishes)

Fittings, furnishings, equipment

Services (e.g., sanitary installations, mechanical and electrical installations)

External works (e.g., site preparation works, roads, paths, pavings and surfacings, bridges, culverts, soft landscaping, planting and irrigation systems, fencing, railings and walls, external fixtures, external drainage)

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

Collection of data

Characteristics

Labour and labour costs

Plant rates data

Company data (on output levels)

Material costs (e.g., terms of supply, delivery, handling, wastage)

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., SMM, NRM, CESMM etc.)

Calculation of unit rates in building up an estimate

Labour rates (e.g., direct, sub-contractors, labour-only sub-contractors [LOSC])

Materials (e.g., purchase price, delivery costs, wastage rate)

Plant (e.g., purchase or hire options, output and capacity)

Overheads and margin

Outputs (e.g., recorded historically, use of price books)

Adjustments to unit rates in building up an estimate

Historical rates adjusted for time

Inflation

Risk

Technology

Alternatives (plant, material, process)

Location (labour costs, material costs)

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 comparative cost data

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

Calculating cost of risk (e.g., 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

Preparing a bill of quantities

Types of BOQ (e.g., approximate, elemental, work package, work section, ‘unpriced’ (Tender Pricing Document))

Standard forms of BOQ (e.g., New Rules of Measurement (NRM), Civil Engineering Standard Method of Measurement (CESMM4), International Construction Measurement Standards (ICMS), International Property Measurement Standards (IPMS), Standard Method of Measurement (SMM7) – legacy)

Learning Outcomes and Assessment Criteria

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

Recommended Resources

Print resources

BROOK, M. (2016), *Estimating and Tendering for Construction Work*, Routledge

CARTLIDGE, D. (2019), *Estimator's Pocket Book Second Edition*, Routledge

GREENHALGH, B. (2013*), Introduction to Estimating for Construction*, Routledge

OSTROWSKI, S. (2013*), Estimating and Cost Planning Using the New Rules of Measurement*, John Wiley & Sons

RICS (2012), *Nrm 1 Rics New Rules of Measurement*, RICS Books

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

Links

This unit links to the following related units:

- Unit 7: Surveying, Measuring & Setting-out
- Unit 8: Mathematics for Construction
- Unit 12: Tender & Procurement
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 36: Value Engineering & Cost Control
- Unit 43: Advanced Surveying & Measurement
- Unit 54: Advanced Quantity Surveying Practice.

Unit 11: Financial Management & Business Practices in Construction

Level: 4

Credits: 15

Ofqual Code: K/618/8090

Introduction

The contemporary construction company operates in a very competitive sector of the economy. The size of company ranges from small to large. The types of company includes sole traders, partnerships, limited companies and public limited companies, working in local, regional and multinational contexts. Construction companies have evolved their business practices to ensure economic survival and growth. However, they continue to be impacted by the construction market and external factors such as interest rates, government legislation and political and economic conditions.

This unit introduces students to the concepts of business management and financial control. They 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 it impacts on raising finance; the different sources of finance and how a company manages them; contemporary management strategies; how the day-to-day management of the different resources used by a construction company have an 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, their business strategies and how they raise and manage their finances, and the management of the resources available to them.

Learning Outcomes

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

LO1 Explain the legal status of different types of construction companies

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

LO3 Evaluate different forms of company organisation in the contemporary construction industry

LO4 Illustrate the different strategies used by construction companies to manage resources.

Essential Content

LO1 **Explain the legal status of different types of construction companies**

Company types

Sole trader

Partnership and limited liability partnership (LLP)

Private company (e.g., limited by shares (Ltd), limited by guarantee, unlimited)

Public company (e.g., public limited (PLC))

Holding and subsidiary companies

Legal statutes surrounding companies

Company law

Responsibility to shareholders

Bankruptcy and insolvency

Key legal characteristics of registered companies

Company registration

Memorandum of Association

Articles of Association

Statement of capital and initial shareholdings

Choosing a company name

Company closure

Winding-up/dissolution or liquidation

Members' voluntary winding-up/dissolution

Creditors' winding-up/dissolution

Compulsory 'strike-off'

Insolvency

Bankruptcy

Administration

Secured and unsecured creditors

Distribution of assets

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

Types of capital

Short-term, medium-term, long-term

Investment types (e.g., owner, shareholder, bondholder, equity, banks, venture, lender/loan)

Types of finance

Equity

Debt and lease financing

Debentures

Shares (e.g., ordinary, preference, 'called-up', share values)

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

Trading position

Balance sheet analysis

Ratio analysis

Financial reporting

Cash flow analysis

LO3 **Evaluate different forms of company organisation in the contemporary construction industry**

Company organisation

Corporate governance

Operational strategies

Corporate ethics (e.g., corporate social responsibility, sustainability, labour practices)

Organisation structures

Span of control

Communication

Matrix organisations

Head office and site management structures

Learning and development (e.g., education, training, professional development)

Health, safety, and welfare provisions

Certification schemes (e.g., Construction Skills Certification Scheme, Considerate Constructors Scheme)

Management philosophies

Human resources development

Motivation and incentivisation

Leadership styles

Employment types (e.g., direct, sub-contract, agency labour)

Collaboration and communication

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

Labour

Skilled or semi-skilled

Sub-contract or direct labour

Incentive schemes

Human resources reviews

Materials

Ordering

Delivery strategies

Storage

Transport

Plant and equipment

Hire, lease, or purchase

Depreciation

Selection process

Setting hire rate

Project cost monitoring

Cost plan

Approved budget

Cost reporting

Roles in cost monitoring (e.g., client, quantity surveyor, project team)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the legal status of different types of construction companies		
P1 Discuss the different types of companies and their legal status. **P2** Explain the process of company formation.	**M1** Compare different company types and advise on a suitable type for a given context.	**D1** Assess the different strategies available for the winding-up or dissolution of a company.
LO2 Explore different sources of finance available to a construction company and strategies used to manage finance		
P3 Explore the different sources of capital available for borrowing by a company. **P4** Discuss a range of techniques for assessing the cost of borrowing.	**M2** Analyse the borrowing requirements for a given project.	**D2** Analyse the balance sheet of a typical construction company.
LO3 Evaluate different forms of company organisation in the contemporary construction industry		
P5 Discuss the strategic policies of a construction company. **P6** Explain the different organisational structures in different sizes of construction company.	**M3** Assess company organisational structures that may support collaborative working practices.	**D3** Appraise a range of different management leadership styles suitable for construction management.
LO4 Illustrate the different strategies used by construction companies to manage resources		
P7 Describe the different types of labour, and strategies used for their management, by construction companies. **P8** Discuss the importance of cost control for projects and the different parties involved in managing costs.	**M4** Discuss the factors to be considered when considering the purchase or hire of plant and equipment.	**D4** Evaluate different strategies for incentivising labour productivity in construction companies.

Recommended Resources

Print resources

GRIFFITH, A. (2018), *Integrated Management Systems for Construction*, Routledge

GRUNEBERG, S., FRANCIS, N. (2019), *The Economics of Construction*, Agenda Publishing

KIRKHAM, R. (2014), *Ferry and Brandon's Cost Planning of Buildings*, John Wiley & Sons

NICHOLSON, M. (2006), *Mastering Accounting Skills*, Macmillan

SHERRATT, F. (2015), *Introduction to Construction Management*, Routledge

Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 12: Tender & Procurement
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 36: Value Engineering & Cost Control
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.

Unit 12: Tender & Procurement

Level: 4

Credits: 15

Ofqual Code: M/618/8091

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 client's expectations 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 of contractor selection to the successful completion of a client's project cannot be overstated.

This unit aims to give students the knowledge they need to be able to select a procurement route and an appropriate tendering method in the awarding of a project to a main contractor. Students will learn 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 in this unit are: tendering constraints and information; the documentation needed to send out a tender; the factors that affect procurement; the procurement methods that can be used to select a contractor.

On successful completion of this unit, students will be able to prepare tender documents for a client's project, at the design stage, using a suitable procurement method. Students will also have the fundamental knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

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

LO2 Explain the procedures and contractual arrangements for tendering

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

LO4 Prepare tender documentation for a given project.

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 stakeholder (e.g., private or commercial clients)

Stage of the design drawings

Provisional timescale

Pre-contract health and safety plans

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

Resource implications in terms of hardcopy

Poor tender presentation (e.g., insufficient information sent out to contractors)

Revisions to design

Tender documentation

Covering invitation letter

Form of tender

Employers' requirements

Nominated and named contractors

Tender submission breakdown

List of drawings

Drawings/data (e.g., design drawings, tender drawings, building information model data)

Specifications

Bill of quantities

Preliminaries

Pre-construction information

Contract information (e.g., form of contract to be used on the project, contract conditions and terms)

Tender documents (e.g., tender pricing document, tender return instructions, tender return envelope)

References to any code of practice for tendering procedures

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 (e.g., experience, references, professional association status, ISO registration, recommendations, clients, preferences, interview, presentation, financial accounts, health and safety record, rotation on a select list, listing against financial capacity, previous performance feedback)

Types of tender

Open

Selective

Negotiated

Serial

Framework tendering

Single-stage and two-stage

Advantages and disadvantages

Criteria for the selection of type of contract

Types of contract/procurement (e.g., traditional, design and build, construction management, measured term)

Standard forms of contract (e.g., Joint Contracts Tribunal (JCT), New Engineering Contract (NEC), FIDIC, International Construction Contracts) Level of information provided at tendering stage

Criteria for the selection of tendering method

Type of contract

Size of project

Financial costs

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

Forms of procurement

Traditional (e.g., design-bid-build, bid-build, employer-designed)

Design and build (e.g., single-stage, two-stage)

Management

Private Finance Initiative (e.g., Build-own-operate-transfer (BOOT), Design-build-finance-maintain (DBFM), Design-build-finance-transfer (DBFT))

Engineering procurement and construction (EPC)

Engineering procurement and construction management (EPCM)

Framework agreements

Others

Issues associated with procurement of projects

Current issues (associated with procurement and contractual arrangements)

Government policy and strategy

Professional body requirements

Contract organisations (e.g., JCT, NEC, FIDIC)

Differences between public and private procurement

Industry developments and trends (e.g., building information modelling, digital asset management)

International trade agreements

Factors affecting procurement routes

Time constraints

Financial constraints (budget, costs and financial planning)

Quality

Client characteristics (e.g., government, institutional, private sector)

Project characteristics

Level of risk associated (e.g., apportionment of risk between client and contractor)

Environmental/sustainability

Stage of the design (e.g., fully designed, partially designed)

Complexity of project

Regulatory/legislation compliance

LO4 **Prepare tender documentation for a given project**

Project parameters

Client's budget

Client's agreed procurement strategy

Project management strategy

Available procurement time in relation to design stage

Construction information availability schedule

Level of specified quality

Policy/political constraints

Value for money

Level of client knowledge.

Contract type in relation to method of procurement

Tender documentation

Letter of invitation

Form of tender

Preliminaries (e.g., pre-construction information, site waste management plan)

Form of contract

Tender pricing document

Employer's information requirements for BIM

Drawings

Specifications

Tender return slip

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Define what constitutes a tender and the information required for this process		
P1 Explain the information required to be produced prior to tendering. **P2** Illustrate the documentation required to formulate a tender for a major project.	**M1** Compare the use of specifications and bills of quantities as tendering methods used for a privately funded project.	**D1** Analyse the potential benefits of Building Information Modelling (BIM) in the tender process.
LO2 Explain the procedures and contractual arrangements for tendering		
P3 Explain the stages of a tender process and the criteria used in selecting tenders. **P4** Discuss the advantages and disadvantages of different types of tender for a given project.	**M2** Compare the different types of tendering available for a design and build project.	**D2** Justify the selection of a contract type for a given form of tender.
LO3 Analyse the factors that affect the selection of construction procurement methods		**D3** Evaluate the relationship between procurement route, contract type and tender process in limiting risk for client and contractor.
P5 Explore the professional, legal and industry issues that influence procurement. **P6** Explain the project factors that inform the selection of a procurement route.	**M3** Analyse the different influences on procurement between public and private projects.	
LO4 Prepare tender documentation for a given project		
P7 Compile project parameters, to inform tender documentation, for a given project. **P8** Produce tender documentation (based on drawings and specifications provided by others) for a given project.	**M4** Justify the approach to tender documentation in relation to the client's agreed procurement strategy.	

Recommended Resources

Print resources

BROOK, M. (2016), *Estimating and Tendering for Construction Work*, Routledge

FINCH, R. (2011), *NBS Guide to Tendering*, Nbs Publications

HUGHES, W., HILLEBRANDT, P., GREENWOOD, D., KWAWU, W., KWAWU, W. (2006), *Procurement in the Construction Industry*, Routledge

MITCHELL, B., TREBES, B. (2005), *Introduction to the Engineering and Construction Contract*, Thomas Telford

MORLEDGE, R., SMITH, A., APPIAH, S. (2021), *Building Procurement*, John Wiley & Sons

Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 8: Mathematics for Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 54: Advanced Quantity Surveying Practice.

Unit 13: Building Information Modelling

Level: 4

Credits: 15

Ofqual Code: T/618/8092

Introduction

Building Information Modelling (BIM) is often assumed to be a software solution – a more advanced form of CAD, for producing construction information. However, while software can play an important part, BIM is actually an approach to information generation and management in a collaborative environment. The aim of BIM is to ensure that better information is created, shared and kept secure so that the design, construction, occupation and maintenance of our built assets can be more efficiently managed. In short, BIM is a collaborative approach that involves a clearly defined set of processes.

The aim of this unit is to give students 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 that surrounds it.

The knowledge and skills gained in this unit will allow students to understand the importance of BIM in the context of current roles and responsibilities in the construction industry. Students will also gain an understanding of how this may influence future choices in their professional careers.

Learning Outcomes

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

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

LO2 Illustrate the key features of Common Data Environment for a given project in relation to information producers and information uses

LO3 Explain the Project Information Model and the Asset Information Model in terms of their use through a project lifecycle

LO4 Assess the benefits of Building Information Modelling (BIM) for the stakeholders involved in a building project.

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 Building Information Modelling (BIM)

Key terms and definitions that relate to BIM

BIM Stages

Project Information Model (PIM)

Asset Information Model (AIM)

Employer's Information Requirements (EIR)

Organisational Information Requirements (OIR)

Asset Information Requirements (AIR)

The differences between traditional methods and a BIM-enabled process

Drawing vs model

Geometry vs information

The 'digital twin'

The importance of BIM in the context of the construction industry

Collaborative practices

Common Data Environment (CDE)

Interoperability

International Standards

ISO 19650 Series – Managing Information with Building Information Modelling (BIM)

ISO 55000 (Asset management overview)

ISO 16739 (Industry Foundation Classes [IFC] for data sharing)

LO2 **Illustrate the key features of Common Data Environment for a given project in relation to information producers and information uses**

The Common Data Environment

Graphical geometric data

Non-graphical geometric data

Benefits of the common data environment

Common Data Formats (e.g., DWG, IFC, COBie, DOCX, XLSX)

Information producers

Information uses

Information management

LO3 **Explain the Project Information Model and the Asset Information Model in terms of their use through a project lifecycle**

Project Information Model

Project Information Requirements (PIR)

Design phase (e.g., design intent model, massing, 2D data, 3D data)

Construction phase (e.g., virtual construction model, details, specifications)

Asset Information Model

Development from Project Information Model

Information management process

Asset Information Requirements

As-built information

Geometric data (e.g., drawings, models)

Non-geometric data (e.g., specifications, schedules, product information, maintenance information)

Information Management Function

LO4 **Assess the benefits of Building Information Modelling (BIM) for the stakeholders involved in a building project**

Potential benefits of BIM

Cost reduction

Time savings

Reducing waste

Minimising errors

Improved efficiency

Design team

Architect

Engineers (e.g., structural, civil, mechanical)

Client/asset owner

Developer

Owner

Construction team

Main contractor

Sub-contractors

Occupier/asset user

Facilities manager/maintenance team

Commercial occupier/user

Residential occupier/user

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the term Building Information Modelling (BIM) in the context of local, national and global developments in the construction industry		
P1 Explain the term 'Building Information Modelling (BIM)' and how it relates to the construction industry. **P2** Discuss the role of standards in defining the processes of Building Information Modelling and ensuring project deliverables and quality.	**M1** Analyse the difference between Building Information Modelling and traditional forms of construction information.	**D1** Evaluate the role of Building Information Modelling in meeting client, user and government targets for construction projects.
LO2 Illustrate the key features of Common Data Environment for a given project in relation to information producers and information uses		
P3 Explain the role of the Common Data Environment for construction projects. **P4** Discuss the benefits of the Common Data Environment.	**M2** Assess the ways that different stakeholders make use of the Common Data Environment.	**D2** Critically analyse the technologies and data formats that support collaboration and interoperability through the Common Data Environment.

Pass	Merit	Distinction
LO3 Explain the Project Information Model and the Asset Information Model in terms of their use through a project lifecycle		**D3** Critically analyse how Information Requirement definitions impact on the potential benefits of a BIM-enabled project.
P5 Discuss the purpose of the Project Information Model and the Asset Information Model. **P6** Present Project Information Requirements and Asset Information requirements for a given project.	**M3** Analyse the transition from Project Information Model to Asset Information Model in terms of the information included in each.	
LO4 Assess the benefits of Building Information Modelling (BIM) for the stakeholders involved in a building project		
P7 Discuss the ways in which a BIM-enabled project creates benefits for clients/owners. **P8** Explain the potential benefits of a BIM-enabled project for users/occupiers.	**M4** Evaluate the benefits of collaboration, through BIM, for members of a project design team.	

Recommended Resources

Print resources

BALLAST, D. (2009), *Architect's Handbook of Construction Detailing*, John Wiley & Sons

BARNES, P. (2020), *BIM for Project Managers*, ICE Publishing

FAIRHEAD, R. (2014), *Information Exchanges*, Riba Publications Limited

HOLZER, D. (2016), *The BIM Manager's Handbook*, John Wiley & Sons

INGRAM, J. (2020), *Understanding BIM*, Routledge

SACKS, R., EASTMAN, C., LEE, G., TEICHOLZ, P. (2018), *BIM Handbook*, John Wiley & Sons

SAXON, R. (2016), *Bim for Construction Clients*, NBS

SHEPHERD, D. (2019), *The BIM Management Handbook*, Routledge

Web resources

https://www.theb1m.com	**The B1M** (General Reference)
https://www.bimtaskgroup.org	**The UK BIM Framework** (General Reference)
https://www.bimtaskgroup.org	**COBie UK 2012** (General Reference)
https://www.thenbs.com	**The NBS Knowledge** (General Reference)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 26: Digital Applications for Building Information Modelling
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 47: Advanced Building Information Modelling.

Unit 14: Principles of Refurbishment

Level: 4

Credits: 15

Ofqual Code: A/618/8093

Introduction

There are buildings all over the world of different types, styles, ages and condition. Once a building has been built, there comes a need to maintain and update the property, to keep it fit for the intended purpose or prepare it for a new use. 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 change and a drive for increased sustainability, the need to understand refurbishment is increasingly important.

This unit gives students the 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, students will be able to:

LO1 Explore the factors that drive refurbishment and its potential benefits and challenges

LO2 Discuss different approaches to refurbishment

LO3 Illustrate the project process for a given refurbishment scheme

LO4 Prepare an initial scheme for a refurbishment project to meet a client brief.

Essential Content

LO1 **Explore the factors that drive refurbishment and its potential benefits and challenges**

Need for refurbishment

Ageing property stock

Obsolescence (economic, functional, physical, social, legal)

Demographic changes

Legislative changes

Deterioration of the fabric

Safety of existing structure

Preservation of the historic environment

Decline in performance

Environmental and sustainability needs

Societal trends

Benefits of refurbishment

Improved sustainability (e.g., better energy performance, reduction in materials)

Retaining local/historical character

Cost reduction (e.g., lower energy costs, lower ongoing maintenance costs)

Improved visual appeal

Increased safety (e.g., fire, environmental)

Challenges of refurbishment

Safety (e.g., work to existing buildings, structural stability)

Financial risks (e.g., value of ‘new’ vs value of refurbished)

Availability of specialist trades/materials (e.g., work to historic buildings)

Sustainability (e.g., ability of building to accommodate sustainable interventions)

LO2 **Discuss different approaches to refurbishment**

Types of refurbishment

Preservation

Conservation

Restoration

Retrofit

Rehabilitation

Renovation

Remodelling

Scale of refurbishment

Small (e.g., minor upgrades of the fabric, small-scale lateral extensions)

Medium (e.g., major upgrades, larger lateral and vertical extensions, radical internal changes and alterations)

Large (e.g., extensive alterations, upgrades and extensions, additional storey above or below ground, façade retention etc.)

LO3 **Illustrate the project process for a given refurbishment scheme**

Project initiation

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 (e.g., initial cost estimate, proceed with refurb or demolish)

Detailed scheme design

Legal considerations (planning, building regulations etc.)

Information production

Tender

Construction

Monitoring works

Checking quality

Managing changes

Handover

Commissioning

Defects (e.g., snagging, correcting defects, defects liability period)

Occupancy

Building regulation compliance

Certificate of occupancy

LO4 **Prepare an initial scheme for a refurbishment project to meet a client brief**

Existing information

As-built drawings

Survey reports

Structural reports

Client brief

Project type (e.g., residential, commercial, industrial)

Client need (e.g., improve performance, make safe, enhance commercial viability, change of use)

Budget

Initial schemes

Design drawings

Cost estimates

Client approval

Legislative compliance

Risk assessment

Detail/production design

Construction drawings

Specifications

Schedules

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore the factors that drive refurbishment and its potential benefits and challenges		
P1 Explain why properties will require refurbishment throughout their lifecycle. **P2** Explain the benefits and challenges of refurbishment in regard to sustainability.	**M1** Compare different forms of obsolescence and how they may contribute to the need for refurbishment.	**D1** Evaluate the value of refurbishment in terms of societal need, environmental impact, time, cost and quality.
LO2 Discuss different approaches to refurbishment		
P3 Explain the different approaches to refurbishment. **P4** Discuss the different scales of refurbishment.	**M2** Analyse a range of refurbishment options and interventions for a given scheme.	**D2** Evaluate the relationship between approach to refurbishment and the information required at different stages in the project process.
LO3 Illustrate the project process for a given refurbishment scheme		
P5 Examine the refurbishment process, including the planning process and building regulations. **P6** Discuss the monitoring of construction and commissioning of finished works to ensure quality.	**M3** Analyse the different forms of information required for a refurbishment project.	
LO4 Prepare an initial scheme for a refurbishment project to meet a client brief		
P7 Produce the information required for an initial refurbishment scheme to meet a client brief. **P8** Prepare a risk assessment for a refurbishment scheme, based on existing conditions.	**M4** Prepare information and applications to meet regulatory requirements for a refurbishment project.	**D3** Justify a refurbishment scheme, highlighting how it addresses issues of obsolescence.

Recommended Resources

Print resources

BAKER, N., BAKER, N. (2009), *The Handbook of Sustainable Refurbishment*, Earthscan

FORSYTH, M. (2014), *Structures and Construction in Historic Building Conservation*, John Wiley & Sons

GLOVER, P. (2009*), Building Surveys*, Elsevier

HIGHFIELD, D., GORSE, C. (2009*), Refurbishment and Upgrading of Buildings*, Routledge

HOXLEY, M. (2019), *Building Condition Surveys*, Routledge

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

NOY, E. (2008), *Building Surveys and Reports*, John Wiley & Sons

PENOYRE, G., PRASAD, S. (2019), *Retrofit for Purpose*, Routledge

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 15: Principles of Alternative Energy
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 36: Value Engineering & Cost Control
- Unit 40: Surveying for Conservation, Renovation & Refurbishment.

Unit 15: Principles of Alternative Energy

Level: 4

Credits: 15

Ofqual Code: F/618/8094

Introduction

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. 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 resulting measures 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 biofuel, these sustainable energy systems are often incorporated into the design of new construction projects.

The aim of this unit is to develop students' knowledge of current and future energy technologies and to be able to apply that knowledge to the analysis and assessment of their effectiveness. Students will also apply their 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:

LO1 Examine the different contexts that inform discussions on environmental sustainability

LO2 Discuss types of alternative energy systems and how they support sustainability

LO3 Explain the factors that inform the selection of a renewable energy system in relation to a specific installation

LO4 Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy.

Essential Content

LO1 **Examine the different contexts that inform discussions on environmental sustainability**

Definitions of sustainability

Environmental sustainability

Social sustainability

Economic sustainability

Cultural sustainability

Environmental context

Effects of CO2 emissions

Greenhouse effect

Waste products and management

Health issues

Impact of construction industry on the environment

Resource context

Non-renewable resources (e.g., fossil fuels, nuclear fuels)

Renewable resources (e.g., wind, solar, biomass)

Environmental cost of renewables (e.g., manufacture, transportation, installation)

Political context

Global agreements (e.g., Kyoto Agreement, Paris Accord)

National/regional targets

Carbon offset and carbon trading

LO2 **Discuss types of alternative energy systems and how they support sustainability**

Renewables

Solar (e.g., solar heating/hot water, photovoltaic systems)

Wind (e.g., wind turbines, windfarms (offshore, onshore), small-scale generation)

Hydro-electrical systems

Geothermal

Wave/tidal power

Biomass (e.g., biofuel, biogas)

Conservation

Combined heat and power (CHP)

Heat pumps

Heat exchangers

Carbon-neutral fuels (e.g., microalgae)

Energy storage

Advances

Robotics (e.g., used for installation, maintenance)

Optical furnaces (used to produce solar cells)

Improved storage (e.g., liquid metal batteries, hydrogen cell)

Solar systems (e.g., sun-tracking solar cells, solar energy harvesting from space, molten salt solar power)

LO3 **Explain the factors that inform the selection of a renewable energy system in relation to a specific installation**

Environmental factors

Effects of weather, light availability and quality

Presence of natural resources needed to drive the system

Political factors

Government targets/policies

Regulatory requirements/obstacles

Social factors

Aesthetics

Neighbours

Conservation

Technical and design factors

Client requirements

Building structure (e.g., Can building support proposed systems?)

Access

Required power output (e.g., electrical, heating, ventilation, cooling)

Regulatory requirements (e.g., planning restrictions, building regulations)

Cost factors

Tariffs and tariff calculations

Installation costs

Cumulative savings

Safety factors

Health and safety regulations

Safety factors in energy generation

Safety factors in energy storage

LO4 **Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy**

Project characteristics

Building use (e.g., residential, commercial, industrial)

Scale

Energy requirements. (e.g., electrical load, heating requirements, ventilation requirements, cooling load)

Client requirements

Budget

Proposed building use

Strategy

System specification (e.g., energy production type, equipment required)

Installation method and requirements (e.g., method statement, health and safety plan, structural requirements, construction requirements, cost estimate)

Monitoring (e.g., monitoring equipment, energy production, energy use, cost)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine the different contexts that inform discussions on environmental sustainability		**D1** Evaluate how different forms of alternative energy systems contribute to achieving a more sustainable construction industry.
P1 Discuss the relationship between different forms of sustainability. **P2** Describe the ways that the construction industry impacts on the environment.	**M1** Assess the political context for sustainability and how the construction industry may contribute to achieving local/regional/global targets.	
LO2 Discuss types of alternative energy systems and how they support sustainability		
P3 Explore the different types of energy systems available and their role in sustainable solutions. **P4** Describe advances in renewable energy technology.	**M2** Assess the impact of advances in renewable energy to improve efficiency, performance and sustainability.	
LO3 Explain the factors that inform the selection of a renewable energy system in relation to a specific installation		**D2** Evaluate how an alternative energy strategy meets client needs and addresses environmental, political and social factors.
P5 Review an existing renewable energy installation for a non-domestic building. **P6** Explain the factors that inform the choice of selected system for the given installation.	**M3** Analyse how a different renewable energy system would impact on the given project.	
LO4 Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy		
P7 Select an appropriate renewable energy system for an existing building. **P8** Present a strategy for an existing building to integrate a form of alternative energy.	**M4** Justify design decisions based on external, cost and design factors.	

Recommended Resources

Print resources

ARMSTRONG, J. (2021), *The Future of Energy: The 2021 Guide to the Energy Transition - Renewable Energy, Energy Technology, Sustainability, Hydrogen and More*, Energy Technology Publishing

DUFFY, A., ROGERS, M., AYOMPE, L. (2015), *Renewable Energy and Energy Efficiency*, John Wiley & Sons

GRINNELL, S. (2015), *Renewable Energy & Sustainable Design*, Cengage Learning

JELLEY, N. (2020), *Renewable Energy: a Very Short Introduction*, Oxford University Press, USA

TWIDELL, J., WEIR, T. (2015), *Renewable Energy Resources*, Routledge

USHER, B. (2019), *Renewable Energy*, Columbia University Press

Web resources

https://energysavingtrust.org.uk	**Energy Saving Trust** (General Reference)
https://www.nrdc.org	**NRDC Renewable Energy: The Clean Facts** (General Reference)

Links

This unit links to the following related units:

- Unit 6: Digital Applications for Construction Information
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 18: Principles of Electrical Design & Installation
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 49: Advanced Electrical Design & Installation.

Unit 16: Principles of Public Health Engineering

Level: 4

Credits: 15

Ofqual Code: J/618/8095

Introduction

The role of a public health engineer is a very important and diverse one in the construction process. Public health engineers 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. They will develop a broad understanding of domestic hot- and cold-water services, and 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, and sanitation and rainwater systems for large commercial buildings.

Learning Outcomes

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

LO1 Explain the different types of domestic water services systems and above ground drainage that serve large buildings

LO2 Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment

LO3 Develop sustainable design strategies for public health engineering

LO4 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 buildings**

Cold water

Sources of water (e.g., water quality, hardness, water treatment, corrosion)

Distribution systems (e.g., direct, and indirect systems, boosted cold water systems, water storage, pressure reduction and control, domestic sprinkler systems)

Hot water

Hot water production (e.g., local vs central, vented and unvented, calorifiers, plate heat exchangers, local heaters)

Distribution systems (e.g., secondary circulation, pumps and balancing, trace heating, avoidance of dead legs)

Above ground drainage

Sanitary pipework systems (e.g., 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 (e.g., 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

Standards and codes of practice

Commissioning and maintenance

Hot water

Legionella prevention vs scalding

Thermal balancing

Hot water temperatures

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

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

Commissioning

System testing

Balancing

Quality checks

Handover

LO3 **Develop sustainable design strategies for public health engineering**

Certification schemes (e.g., BREEAM, 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)

Solar thermal

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

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
LO1 Explain the different types of domestic water services systems and above ground drainage that serve large buildings		**D1** Evaluate how different water, sanitation systems and plant choices impact on the construction and performance of a building.
P1 Identify the main hot and cold water and sanitation systems for large buildings. **P2** Describe the main plant items for water and sanitation systems.	**M1** Illustrate the operation of a hot and cold water and sanitation system for a given building type.	
LO2 Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment		
P3 Explain the current legislation and codes of practice that influence the design and selection of water and sanitation systems. **P4** Discuss the health and public safety issues that must be managed through water and sanitation installations for large buildings.	**M2** Analyse the way in which industry codes of practice influence the design of water and sanitation systems.	

Pass	Merit	Distinction
LO3 Develop sustainable design strategies for public health engineering		
P5 Explain how public health engineering solutions contribute to project sustainability. **P6** Produce a design strategy for a public health engineering installation in a given context.	**M3** Compare sustainable design strategies for public health engineering in relation to a given context.	**D2** Evaluate the impact of incorporating a sustainable public health scheme within a proposal.
LO4 Design and specify water and sanitation services for large non-domestic buildings		
P7 Explain the parameters that inform the design of public health engineering services for a given large, non-domestic building. **P8** Produce drawings and specifications for water and sanitation services in a given large, non-domestic building.	**M4** Calculate the required plant and pipe sizes for a public health engineering design proposal.	

Recommended Resources

Print resources

BUTLER, D., DAVIES, J. (2017), *Urban Drainage*, CRC Press

CHADDERTON, D. (2004), *Building Services Engineering*, Routledge

GARRETT, R. (2008), *Hot and Cold Water Supply*, John Wiley & Sons

HALL, F., GREENO, R. (2017), *Building Services Handbook*, Taylor & Francis

MITCHELL, P. (2008), *Central Heating, Installation, Maintenance and Repair*, WritersPrintShop

RIFFAT, R. (2012), *Fundamentals of Wastewater Treatment and Engineering*, CRC Press

YOUNG, L. (2000), *Water Regulations Guide*, Water Regulations Advisory Scheme

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 22: Scientific Principles for Building Services
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 43: Advanced Surveying & Measurement.

Unit 17: Civil Engineering Technology

Level: 4

Credits: 15

Ofqual Code: R/618/8097

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 and substructures are crucial in supporting 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 their 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:

LO1 Explain the methods and techniques used in civil engineering for earthworks and substructures

LO2 Discuss the civil engineering technologies associated with road and bridge construction

LO3 Evaluate the way a given civil engineering project addresses issues related to the environment, structural requirements, economics and quality

LO4 Present 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

Excavation (e.g., topsoil, earth, rock, unclassified)

Shoring (e.g., raking shores, dead shores, flying shores)

Temporary support (e.g., trench sheeting, wailings and struts, trench boxes, raking, dead and flying shores)

Slope stability

Dewatering

Pumping (e.g., centrifugal pumps, displacement pumps, submersible pumps, air-lift pumps)

Evaporation (filter presses, drying beds, sludge lagoons)

Disposal of water (e.g., removal of solids, evaporation, sewerage systems, watercourses)

Water cut-off (e.g., grouting)

Substructures

Shallow foundations (e.g., strip, pad, raft)

Deep foundations (e.g., piles, mini-piles, pile walls, diaphragm walls, caissons)

LO2 **Discuss the civil engineering technologies associated with road and bridge construction**

Roads and highways

Traffic loads (e.g., class of highway)

Geotechnical parameters

Culverts

Subgrade strengthening (e.g., compaction, subsoil drainage, stabilisation)

Flexible paving (e.g., materials, wearing course, base course, sub-base, capping layer)

Rigid paving (e.g., reinforced, unreinforced, expansion joints)

Edging and kerbs

Drainage (e.g., gullies, drains, manholes, soakaways, retention ponds)

Bridges

Bridge types (e.g., beam, truss, cantilever, arch, tied arch, suspension, cable stayed)

Road bridges and overpasses

Rail bridges

Bridge elements (e.g., piers, pier caps, pilings, arches, bearings, abutments, decking)

LO3 **Evaluate the way a given civil engineering project addresses issues related to the environment, structural requirements, economics and quality**

Environment

Materials (e.g., material selection, supply chain, transport)

Construction method and impact

Structural

Effectiveness of structural solution

Alternative solutions

Economic

Construction cost

Maintenance cost

Quality

Addressing client needs

Meeting regulatory requirements

Ensuring Security (e.g., on-site assets, cyber security, project data and personal data) and Ethical use of data and information

Ensuring health and safety

Professional bodies (e.g., code of conduct, code of practice)

LO4 **Present a design proposal for a new infrastructure project**

Client brief

Project type

Stakeholder need

Budget

Feasibility

Geotechnical conditions

Site access

Structural requirements

Environmental impact

Initial design

Structural solution

Material selection

Initial cost estimate

Material costs

Labour costs

Plant costs

Health and safety

Method statements

Risk assessments

Building regulations

Security (e.g. safety of materials, equipment, machinery, data and personal information)

Presentation

Graphical material (e.g., drawings, photographs, charts)

Written material (e.g., reports, specifications)

Presentation type (e.g., report, audio-visual)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the methods and techniques used in civil engineering for earthworks and substructures		**D1** Evaluate the impact of ground conditions and slope stability for civil engineering projects and methods to stabilise the condition.
P1 Discuss earthworks and dewatering activities, equipment and techniques. **P2** Describe methods and techniques used to create civil engineering substructures.	**M1** Compare the effectiveness of different dewatering techniques in civil engineering.	
LO2 Discuss the civil engineering technologies associated with road and bridge construction		
P3 Identify the key factors that inform the design of roads, highways and overpasses. **P4** Explain the different types of bridge and their applicability to different site conditions.	**M2** Assess the performance of rigid and flexible paving systems for road and highway design.	
LO3 Evaluate the way a given civil engineering project addresses issues related to the environment, structural requirements, economics and quality		**D2** Justify a design proposal for a new infrastructure project in relation to its ability to address environmental, structural, economic and quality issues.
P5 Explain the construction method of a given civil engineering project. **P6** Discuss how a given civil engineering project addresses environmental, structural, economic, quality, security and risk issues.	**M3** Analyse the relationship between environmental, structural and economic responses in a given civil engineering project.	
LO4 Present a design proposal for a new infrastructure project		
P7 Identify the key stakeholders for an infrastructure project. **P8** Present a civil engineering design proposal for a new infrastructure project, including feasibility, cost, security and health and safety.	**M4** Evaluate health and safety method statements and risk assessments for a new infrastructure proposal.	

Recommended Resources

Print resources

ARYA, C. (2009), *Design of Structural Elements*, CRC Press

CHUDLEY, R., GREENO, R. (2006), *Advanced Construction Technology*, Pearson Education

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), *Chudley and Greeno's Building Construction Handbook*, Butterworth-Heinemann

ROGERS, M., ENRIGHT, B. (2016), *Highway Engineering*, John Wiley & Sons

SOMAYAJI, S. (2001), *Civil Engineering Materials*, Pearson College Division

YUAN, Q., LIU, Z., ZHENG, K., MA, C. (2021), *Civil Engineering Materials*, Elsevier

Web resources

https://www.icevirtuallibrary.com	**ICE Virtual Library** (General Reference)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)
https://www.standardsforhighways.co.uk	**Standards for Highways** (General Reference)
https://www.engc.org.uk/security	**Engineering Council** (Guidance on Security)

Links

This unit links to the following related units:

- Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)
- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 8: Mathematics for Construction
- Unit 13: Building Information Modelling
- Unit 20: Site Supervision & Operations
- Unit 21: Geotechnics & Soil Mechanics
- Unit 26: Digital Applications for Building Information Modelling
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 41: Highway Engineering
- Unit 42: Hydraulics
- Unit 47: Advanced Building Information Modelling.

Unit 18: Principles of Electrical Design & Installation

Level: 4

Credits: 15

Ofqual Code: Y/618/8098

Introduction

While people have studied electricity since the 17th century and have 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 previously mundane tasks simple.

This unit aims to give students a broad understanding of electrical machines, distribution of electric energy and lighting design basics. Students will develop 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:

LO1 Discuss the fundamentals of electricity, magnetism, transformers and circuits

LO2 Analyse the performance, operation and control of AC and DC motors

LO3 Explain the different methods of electricity generation and distribution

LO4 Present a proposal for a non-domestic lighting installation in a given project.

Essential Content

LO1 **Discuss the fundamentals of electricity, magnetism, transformers and circuits**

Magnetic circuits

Magnetic flux

Magnet types (e.g., permanent, electromagnet)

Magnetic cores (e.g., ferromagnetic materials)

Uses of magnetic circuits (e.g., motors, generators, relays)

Transformers

Real vs ideal transformers

Law of induction

Construction (e.g., cores, windings, cooling, insulation)

Electric circuits

Electrical field

Movement of charge

Electrical current (e.g., alternating, direct)

Resistance

Ohm's Law

Series circuits

Parallel circuits

Combination circuits

LO2 **Analyse the performance, operation and control of AC and DC motors**

DC motors

Components (e.g., stator, armature, rotor, brushes)

Lorentz force law

Types (e.g., series, permanent magnet, shunt/parallel, compound)

Operation and applications

AC motors

Components (e.g., alternator, stator, rotor, enclosure)

Types (e.g., brushless, induction, synchronous, shaded-pole)

Phases (single-phase motors, 2-phase motors, 3-phase motors)

Operation and applications

AC motor advantages

Long lifespan (durability)

Multi-phase configurations (e.g., can use mains current)

Produces less heat

Typically, more powerful (good for higher power applications)

AC motor disadvantages

Typically, larger, less applicable to portable systems

Requires higher startup current

DC motor advantages

Simple installation

Better speed control

Low maintenance

Produces less electromagnetic interference

Fast response (start/stop/acceleration)

Can run on battery power

DC motor disadvantages

Less efficient

Typically, more expensive

Higher failure rate (brushed type)

Cannot use mains electricity directly (requires transformer)

Selection criteria

Input power source

Environment (e.g., dry or wet, clean or dusty, ambient temperature)

Performance required (e.g., constant speed, torque output required, maintenance cycle)

LO3 **Explain the different methods of electricity generation and distribution**

Types of electrical load

Resistive

Inductive

Capacitive

Calculations for assessing electrical load

Commercial electrical load

Domestic electrical load

Generation and distribution

Non-renewable generation (e.g., coal, gas, nuclear)

Renewable generation (e.g., solar, wind, hydro, wave)

Transmission (e.g., overhead lines, underground lines)

Substations (e.g., transformers, step-down)

Consumer units

Uninterruptible Power Supply (UPS)

Types (e.g., offline/standby, line-interactive, online/double-conversion)

Batteries (e.g., battery types, series-parallel, testing)

Uses (e.g., commercial, industrial, residential)

LO4 **Present a proposal for a non-domestic lighting installation in a given project**

Project type (e.g., commercial, industrial, multi-occupancy residential)

Lighting requirements

Room types

Lighting levels

Lumens, candela, flux

Lamps and luminaries

Incandescent

Fluorescent (including compact fluorescent)

Halogen (including tungsten halogen)

Mercury vapour

Metal halide

Sodium vapour (including high pressure and low pressure)

Light Emitting Diode (LED)

Selection and specification of lamps and luminaries

Lamp type and application

Lamp type and output

Lamp type and operational lifespan

Lamp type and energy consumption

General and emergency lighting installations

Contracts

Consultancy

Sub-contracts

Management

Installation

Maintenance

National and local regulations

Health and safety legislation

Installation safety and service safety (e.g., clothing, insulated matting, insulated tools, earthing, detection equipment)

Operational safety requirement (e.g., fuses, residual current devices)

Building regulations (including conservation of fuel and power)

Installation testing and commissioning

Certification

Sign-off

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the fundamentals of electricity, magnetism, transformers and circuits		**D1** Evaluate the use of electrical or magnetic circuits for a given range of non-domestic applications.
P1 Explain the performance of electrical and magnetic circuits, including transformers. **P2** Illustrate the key principles of parallel and series circuits.	**M1** Design a simple electrical circuit for a given non-domestic building.	
LO2 Analyse the performance, operation and control of AC and DC motors		**D2** Assess the suitability of AC and DC motors for a given non-domestic context.
P3 Analyse the principles that underpin the operation and control of AC and DC motors. **P4** Calculate the performance of given AC and DC motors.	**M2** Select a motor, based on performance needs, for a given non-domestic application.	

Pass	Merit	Distinction
LO3 Explain the different methods of electricity generation and distribution		**D3** Evaluate the relationship between lighting design and electrical circuit design for a non-domestic installation.
P5 Discuss different methods of electricity generation. **P6** Describe the equipment used for different methods of electrical distribution.	**M3** Calculate the electrical load for a given non-domestic building to enable selection of a suitable distribution panel.	
LO4 Present a proposal for a non-domestic lighting installation in a given project		
P7 Present a proposal for non-domestic lighting installation, including calculations to support design, selection of equipment and energy consumption for a given project. **P8** Discuss strategies to ensure health and safety during installation and operation of a non-domestic electrical installation.	**M4** Illustrate circuits and distribution for a non-domestic lighting design proposal.	

Recommended Resources

Print resources

BRANDI, U. (2012), *Lighting Design*, Walter de Gruyter

CATHEY, J. (2001), *Electric Machines*, McGraw-Hill Science, Engineering & Mathematics

CHAPMAN, S. (2002), *Electric Machinery and Power System Fundamentals*, McGraw-Hill Science Engineering

GURU, B., HIZIROGLU, H. (1995), *Electromagnetic Field Theory Fundamentals*, Oxford University Press, USA

HAMBLEY, A. (2018), *Electrical Engineering*, Pearson

KARLEN, M., SPANGLER, C., BENYA, J. (2017), *Lighting Design Basics*, John Wiley & Sons

WILDI, T. (2013), *Electrical Machines, Drives and Power Systems: Pearson New International Edition*, Pearson Higher Ed

Links

This unit links to the following related units:

- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 8: Mathematics for Construction
- Unit 15: Principles of Alternative Energy
- Unit 34: Further Mathematics for Construction
- Unit 49: Advanced Electrical Design & Installation.

Unit 19: Principles of Structural Design

Level: 4

Credits: 15

Ofqual Code: D/618/8099

Introduction

Buildings, bridges, roads and many other types of man-made structures are critical to the economic and social wellbeing of our society. We rely on these structures to provide us with suitable spaces and infrastructure to support our daily lives. In this unit, students will explore the fundamental principles of structural design, codes of practice and standards required to construct safe, effective static structures commonly used in today's building and 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; 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:

LO1 Calculate bending moments and shear forces for simply supported steel and concrete beams

LO2 Determine deflection for different types of beams and loading conditions

LO3 Calculate the axial load carrying capacity of steel and reinforced concrete columns

LO4 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 and safety regulations

Bending moments

Bending moment diagrams

Shear forces

Shear force diagrams

LO2 **Determine deflection for different types of beams and loading conditions**

Types of beam

Simply supported

Cantilevered

Continuous

Fixed

Loading conditions

Uniformly distributed loads

Point loads

Deflection

Unit of deflection

Cantilever deflection

Simply supported deflection

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 (BIM) for structures

Collaboration (e.g., roles, workflows, professional relationships)

Coordination (e.g., information coordination, information sharing, clash detection)

Common Data Environment

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Calculate bending moments and shear forces for simply supported steel and concrete beams		
P1 Determine the following by calculations and diagrams: bending moments and shear force in simply supported steel beams with point loads and uniformly distributed loads. **P2** Discuss the statutory requirements to ensure safety in structural designs.	**M1** Produce valid factors of safety for live loads, dead loads and imposed loads, using current codes of practice and building regulations.	**D1** Evaluate how maximum bending moments determine steel beam selection, using current codes of practice and approved documents in terms of economics and safety.
LO2 Determine deflection for different types of beams and loading conditions		
P3 Calculate the deflection for different types of beam under different loading conditions. **P4** Explain how deflection in beams affects structural stability.	**M2** Analyse different support methods and their effect on deflection in fixed structures.	**D2** Assess the most effective support method for a given scenario, in terms of ease and speed of construction, economics, safety and environmental factors.
LO3 Calculate the axial load carrying capacity of steel and reinforced concrete columns		
P5 Describe the concepts of slenderness ratio and effective length. **P6** Determine the axial load-carrying capacity of steel columns and reinforced concrete columns.	**M3** Analyse the load-carrying capacity, size, weight and corrosion resistance properties of different materials used for beams and columns in fixed structures.	
LO4 Explore design methods for steel, reinforced concrete beams and columns		
P7 Develop a design solution, including beam design and column design, for a given scenario. **P8** Produce drawings and specifications in support of a structural design solution.	**M4** Evaluate the use of an alternative material in achieving a design solution, discussing the benefits or challenges associated with it.	**D3** Assess the use of Building Information Modelling in the production of accurate structural design information and the collaborative environment of structural design.

Recommended Resources

Print resources

ARYA, C. (2009), *Design of Structural Elements*, CRC Press

BHATT, P., MACGINLEY, T., CHOO, B. (2014), *Reinforced Concrete Design to Eurocodes*, CRC Press

COBB, F. (2020), *Structural Engineer's Pocket Book British Standards Edition*, CRC Press

MCKENZIE, W. (2015), *Design of Structural Elements*, Macmillan International Higher Education

MOSLEY, W., HULSE, R., BUNGEY, J. (2012), *Reinforced Concrete Design*, Macmillan International Higher Education

NAGEIM, H., DURKA, F. (2003), *Structural Mechanics*, Pearson Education

OZELTON, E., BAIRD, J. (2008), *Timber Designers' Manual*, John Wiley & Sons

REYNOLDS, C., STEEDMAN, J., THRELFALL, A. (2007), *Reinforced Concrete Designer's Handbook*, Eleventh Edition, CRC Press

SEWARD, D. (2014), *Understanding Structu*res, Macmillan International Higher Education

SMITH, P. (2001), *An Introduction to Structural Mechanic*s, Macmillan International Higher Education

SOMAYAJI, S. (2001), *Civil Engineering Materials*, Pearson College Division

Web resources

https://www.cices.org	**Chartered Institution of Civil Engineering Surveyors** (Professional Body)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)
https://www.iabse.org	**International Association for Bridge and Structural Engineering** (Professional Body)
https://www.istructe.org	**The Institution of Structural Engineers** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 34: Further Mathematics for Construction
- Unit 35: Sustainable Methods of Construction
- Unit 41: Highway Engineering
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling.

Unit 20: Site Supervision & Operations

Level: 4

Credits: 15

Ofqual Code: J/618/8100

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 the safety of those working on the project.

Topics covered in this unit include: reviewing construction information; monitoring quality; identifying and notifying of defects; site safety regulations; health and safety regulations; people management; performance management; site meetings; contractor and sub-contractor relations.

In this unit, students will develop the skills and techniques needed to manage the people and processes of a building site, ensuring the quality of work, safe working practices and the interactions of different 'trades'.

Learning Outcomes

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

LO1 Review construction information to determine quality requirements

LO2 Illustrate the ways in which monitoring of construction projects ensures quality and safety

LO3 Explain the different stages in the management of a construction project

LO4 Discuss methods for assessing and improving the performance of site staff.

Essential Content

LO1 **Review construction information to determine quality requirements**

Construction information

Drawings

Specifications

Schedules

Building Information Modelling (BIM)

Managing quality

Client requirements

Building regulations

Health and safety regulations

Professional code of conduct

LO2 **Illustrate the ways in which monitoring of construction projects ensures quality and safety**

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/designer

Civil engineer

Clerk of works

Client

Contractors/sub-contractors

Site staff

LO3 **Explain the different stages in the management of a construction project**

Construction design management

Client responsibilities

Professional responsibilities

Information recording and sharing

Statutory health and safety requirements

Site safety monitoring

Responsibilities

Notifications

Risk assessment and management

Construction project management principles

Project execution plan

Procurement route and contract

Risk management

Value management

Cost management and payment validation

Monitoring programme and costs

Resource management (e.g., materials, plant, labour)

Client reporting

Managing handover and occupation

LO4 **Discuss methods for assessing and improving the performance of site staff**

Working relationships

Effective communication

Motivation

Managing conflict

Managing change

Equality and diversity

Performance monitoring and evaluation

Supervision and supervisors

Target setting

Review

Self-evaluation

Supervisor evaluation

Peer evaluation

Training and development needs

Improving safety and reducing risk

Site manager responsibilities

Leadership techniques

Identifying staff training needs

Training and development planning

Continuing Professional Development (CPD)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Review construction information to determine quality requirements		**D1** Evaluate the relationship between client requirements, statutory requirements and addressing defects with regard to the impact on quality and safety.
P1 Document the quality requirements for a given project through the review of drawings, specifications and schedules. **P2** Explore the relationship between project quality requirements and statutory requirements.	**M1** Assess the impact of changes to project quality that are necessary to meet statutory requirements.	
LO2 Illustrate the ways in which monitoring of construction projects ensures quality and safety		
P3 Discuss the role of site visits in monitoring progress and quality in construction projects. **P4** Describe the purpose of on-site testing of materials, components and systems.	**M2** Analyse the difference between patent and latent defects and their associated implications for remedial actions.	
LO3 Explain the different stages in the management of a construction project		**D2** Evaluate the impact of health and safety violations on construction projects.
P5 Describe the key principles of construction project management. **P6** Discuss the importance of construction design management for ensuring site safety.	**M3** Compare different techniques for planning and managing resources.	
LO4 Discuss methods for assessing and improving the performance of site staff		**D3** Analyse the relationship between performance management and health and safety legislation.
P7 Describe the methods for assessing the performance of team members. **P8** Discuss the importance of equality and diversity on company/team performance.	**M4** Propose training and development strategies to improve team performance.	

Recommended Resources

Print resources

BARBER, J. (2002), *Health and Safety in Construction*, Thomas Telford

CIOB (THE CHARTERED INSTITUTE OF BUILDING) (2008), *Code of Practice for Project Management for Construction and Development*, John Wiley & Sons

COLES, D., BAILEY, G., CALVERT, R. (2012), *Introduction to Building Management*, Routledge

COOKE, B., WILLIAMS, P. (1998), *Construction Planning Programming and Control*, Macmillan International Higher Education

HARRIS, P., MCCAFFER, P., BALDWIN, P., EDUM-FOTWE, P. (2020), *Modern Construction Management*, John Wiley & Sons

HUGHES, P., FERRETT, E. (2015), *Introduction to Health and Safety in Construction*, Routledge

LOOSEMORE, M., DAINTY, A., LINGARD, H. (2003), *Human Resource Management in Construction Projects*, Routledge

OLANREWAJU, A., ABDUL-AZIZ, A. (2014), *Building Maintenance Processes and Practices*, Springer

Web resources

https://www.ciob.org	**Chartered Institute of Building** (Professional Body)
https://www.pmi.org	**Project Management Institute** (Professional Body)
https://www.cipd.co.uk	**Chartered Institute of Personnel and Development** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 8: Mathematics for Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 46: Transport Systems in Buildings.

Unit 21: Geotechnics & Soil Mechanics

Level: 4

Credits: 15

Ofqual Code: L/618/8101

Introduction

This unit explores the essential relationship between the things we construct and the capacity of the ground to support these constructions. The ability to understand, analyse and develop solutions related to soil and rock is a key aspect of the design and construction of buildings and infrastructure.

Topics included in this unit are: rock type; soil description and classification; methods and techniques used when undertaking site investigations and laboratory testing; determination of soil properties; 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:

LO1 Discuss rock types, their formation and uses in civil engineering and building projects

LO2 Explain the description and classification of soils using current codes of practice

LO3 Analyse soil properties determined by geotechnical procedures

LO4 Produce proposals to address identified geotechnical weaknesses and problems.

Essential Content

LO1 **Discuss rock types, their formation and uses in civil engineering and building projects**

Rock types, formation, and classification

Types (e.g., igneous, sedimentary, metamorphic)

Formation (e.g., lithification, crystallisation and fractional crystallisation)

Classification systems

Weathering and weathering processes

Physical (e.g., freeze-thaw, exfoliation)

Chemical (e.g., rainwater reactions, clays, soluble salts)

Biological (e.g., trees, roots, animals, algae, lichen, bacteria)

Discontinuous nature of rock mass

Mechanical vs Integral discontinuity

Types of discontinuity (e.g., bedding, schistosity, foliation, joint, cleavage, fracture, fissure, folds, faults)

The use of rock in civil engineering and construction

Foundations

Walls and retaining walls

Bridge piers and abutments

Cement and mortars

Erosion protection

Filtration

Pavements, roads

Flooring, cladding, tiles

Uncemented sediments

Earthen dams

Railway ballast

Fill materials

Concrete aggregates

Other

LO2 **Explain the description and classification of soils using current codes of practice**

Soil sampling

Types of sampling (e.g., disturbed, undisturbed)

Soil types

Very coarse (e.g., boulders, cobbles)

Coarse (e.g., sand, gravel)

Fine (e.g., clays, silts)

Organic (e.g., organic clay, sand, silt, peat)

Other (e.g., calcareous, plastic, sediments)

Soil description and classification

Soil analysis

Particle analysis (e.g., sieve, hydrometer)

Particle size distribution

Soil specific gravity

Soil plasticity index

LO3 **Analyse soil properties determined by geotechnical procedures**

Shear strength

Cohesion

Internal friction and angle of internal friction

Mohr's Circle of Stress

Coulomb's Strength Theory

Tests (e.g., direct shear, triaxial compression, unconfined compression, vane shear)

Stages (e.g., consolidation stage, shear stage)

Tests based on drainage conditions

Compressibility and consolidation

Stages (e.g., initial, primary, secondary)

Moisture content (e.g., effect on compression/compaction, effect on bearing capacity)

Soil density

Bulk density

Dry density

Density of solids

Saturated density

Submerged density

Density index

Moisture content

Void ratio

Liquid and plasticity indices

Atterberg limits test

California bearing ratio (CBR)

LO4 **Produce proposals to address identified geotechnical weaknesses and problems**

Project type (e.g., building, infrastructure)

Embankment design

Shear strength

Soil compaction

Road requirements

Rail requirements

Foundation design

Loading

Foundation type (e.g., pad, piling, strip, deep strip, raft)

Soil compressibility

Liquid and plasticity indices

Bearing capacity

Highway design

Highway/road type (e.g., residential, industrial, motorway)

Paving type (e.g., flexible, rigid)

California bearing ratio

Health and safety requirements

Site safety

Temporary works safety

Incident reporting

Certification

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss rock types, their formation and uses in civil engineering and building projects		
P1 Explain rock type formation and classification. **P2** Analyse the discontinuous nature of rock mass and the impact of weathering.	**M1** Analyse the use of rock and uncemented sediments in civil engineering and building projects.	**D1** Evaluate case studies that address problems caused by the discontinuous nature of rock mass when tunnelling and constructing bridges.
LO2 Explain the description and classification of soils using current codes of practice		
P3 Discuss the description and classification of soils based on particle size, specific gravity and plasticity indices, using current codes of practice. **P4** Describe the processes and techniques used in soil sampling and site investigation.	**M2** Analyse methods and techniques used in ground and site investigation, and soil sampling.	**D2** Assess the importance of site investigation, soil sampling and determination of soil properties for infrastructure projects.
LO3 Analyse soil properties determined by geotechnical procedures		
P5 Explain different types of analysis used to measure soil properties. **P6** Analyse soil properties, including moisture content, density, specific gravity, shear strength compressibility, liquid and plasticity indices, and California bearing ratio.	**M3** Evaluate results from soil properties testing.	**D3** Integrate test data to inform the development of design proposals to address identified geotechnical weaknesses in a given site.
LO4 Produce proposals to address identified geotechnical weaknesses and problems		
P7 Identify geotechnical weaknesses and issues for a given site. **P8** Present design proposals to address geotechnical problems for a given site.	**M4** Justify the approach to a design proposal in meeting identified geotechnical weaknesses.	

Recommended Resources

Print resources

CHUDLEY, R., GREENO, R. (2006), *Advanced Construction Technology*, Pearson Education

GREENO, R. (2014), *Mitchell's Introduction to Building*, Routledge

GRIBBLE, C., MCLEAN, A. (2017), *Geology for Civil Engineers*, CRC Press

Web resources

https://www.ciob.org	**Chartered Institute of Building** (Professional Body)
https://www.geology.com	**Geology.com – Geology News and Information** (General Reference)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)
https://www.thomastelford.com	**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 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 41: Highway Engineering
- Unit 42: Hydraulics.

Unit 22: Scientific Principles for Building Services

Level: 4

Credits: 15

Ofqual Code: R/618/8102

Introduction

Building services engineering is based on the application of scientific principles, requiring an understanding of key mathematical formulae.

In 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 in which 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 an 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:

LO1 Calculate energy transfer rates in different building services contexts

LO2 Evaluate conditions of static and dynamic fluid flow to determine energy loss

LO3 Design electrical circuits for single-phase AC networks

LO4 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

Convection

Radiation (e.g., black body, grey body)

Evaporation

Stefan's Constant

Insulated surfaces

Insulation and cost

Condensation risk (e.g., 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 (e.g., composite structures, pipes and ducts, complex structures, thermally bridged structures, thermal conductivity, heat transfer coefficients)

Heat conduction rates (e.g., 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 (e.g., pressure, velocity, density, mass and 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 (e.g., Venturi meter, orifice plate, pitot-static tubes)

Energy losses

Frictional losses (e.g., 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 (e.g., guttering, channels, drainage pipes and soil/waste stacks)

Formulae (e.g., 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 and 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 (e.g., 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 (e.g., external sources, internal sources)

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
LO1 Calculate energy transfer rates in different building services contexts		
P1 Determine heat transfer through different forms of composite structure. **P2** Determine the risk of interstitial condensation in multi-leaf plane structures. **P3** Calculate conduction rates used in various building services plant and equipment.	**M1** Evaluate the impact of heat transfer on thermal comfort and efficiency of building services plant and equipment.	**D1** Critically evaluate the efficiency of different forms of heat transfer for a given range of heat emitters, plant and equipment.
LO2 Evaluate conditions of static and dynamic fluid flow to determine energy loss		
P4 Discuss the types of fluid flow, fluid energy and the potential mechanisms of energy loss. **P5** Calculate the energy loss in pipe and duct networks, using appropriate formulae.	**M2** Analyse the relationship between frictional energy loss under different gravitational flow conditions.	**D2** Critically evaluate fluid flow and energy principles in relation to their application in the design and control of building services engineering.
LO3 Design electrical circuits for single-phase AC networks		
P6 Discuss the difference between resonant and non-resonant circuits. **P7** Design resonant and non-resonant circuits, for single-phase AC networks; calculating current flow.	**M3** Compare the effect of varying resistance, capacitance and inductance in parallel and series AC circuits on voltage, resistance and impedance.	**D3** Analyse the methods to improve the power factor of a given circuit.
LO4 Determine the effects of sound and vibration related to building services and human comfort		
P8 Explain the principles of sound and vibration on room acoustics and their impact on human hearing. **P9** Determine the transmission paths of sound from building services systems through different forms of structure.	**M4** Assess the potential reduction of sound transmission through insulation and attenuation strategies, based on comparison of results of appropriate calculations.	**D4** Evaluate different forms of anti-vibration mounting to minimise building services acoustic sound power levels.

Recommended Resources

Print resources

CHADDERTON, D. (2004), *Building Services Engineering*, Routledge

GREENO, R. (2014), *Building Services, Technology and Design*, Routledge

HALL, F., GREENO, R. (2017), *Building Services Handbook*, Taylor & Francis

HORSLEY, M., KEITH, S. (1996), *Thermofluids*, CRC Press

MCMULLAN, R. (1998), *Environmental Science in Building*, Macmillan International Higher Education

MOSS, K. (2002), *Heat and Mass Transfer in Building Services Design*, Routledge

OUGHTON, D., HODKINSON, S., BRAILSFORD, R. (2014), *Faber & Kell's Heating and Air-Conditioning of Buildings*, Routledge

Web resources

https://www.bsria.com	**Building Services Research and Information Association** (Professional Body)
https://www.cibse.org	**Chartered Institution of Building Services Engineers** (Professional Body)
https://www.engineeringtoolbox.com	**The Engineering Toolbox** (General Reference)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation.

Unit 23: Construction Economics & Sustainability

Level: 4

Credits: 15

Ofqual Code: H/618/8136

Introduction

Construction is both a major influence on, and is influenced by, the economy. The construction sector has considerable impact on local, regional and national economies. However, it is also highly dynamic and responds to fluctuations in broader global economies.

When considering construction economics, we must also consider other factors that will influence the cost and viability of construction projects. Both political and social factors have a role in shaping the way that construction projects can be achieved. Thus, during the planning and execution phases of a project, a quantity surveyor must be aware of and seek to integrate the influence that social, political and economic factors will have on project costs, procurement and design.

Students will gain insight into the ways that political, social and economic factors influence construction. Through this, they will consider the relationship between these factors and how they are reflected in a project and in the broader economy. To integrate this knowledge, students will examine projects to evaluate the way that construction economics, combined with societal and political factors, may influence construction costs and procurement route.

Learning Outcomes

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

LO1 Discuss the political, economic, social and environmental factors that influence the construction industry

LO2 Assess the relationship between economic factors, material and labour costs

LO3 Explore strategies for construction procurement that address economic, social, environmental and political challenges

LO4 Present an analysis of an existing or proposed development in relation to the economic, social and political factors influencing its success.

Essential Content

LO1 **Discuss the political, economic, social and environmental factors that influence the construction industry**

Construction sector

Supply and demand

Equilibrium

Stakeholders

Political influences

Legislation

Taxation

Tax credits, deductions and subsidies

Political uncertainty

Economic influences

Economic model (e.g., free market economy, command/planned economy)

Investment (e.g., investor types, investment types, return on investment (ROI))

Economic indicators (e.g., GDP, Retail Price Index, manufacturing activity, employment statistics)

Economic subsidies

Market influence (e.g., inflation/deflation, recession/depression)

Interest rates

Regional variations

Profit

Social influences

Demographic changes

Social trends

Attitudes

Environmental influences

Environmental impact (e.g., carbon emissions, materials and scarcity, energy use)

Environmental initiatives (e.g., industry goals, government targets)

LO2 Assess the relationship between economic factors, material and labour costs

Factors influencing material costs

Material type (e.g., raw, processed, product)

Material supply (e.g., local, international, import taxes, tariffs, customs)

Transport

Availability (e.g., scarcity, sustainability, renewable)

Factors influencing labour costs

Labour availability (e.g., demographics, trades, professions, skills shortages)

Labour relations (e.g., unionised labour, casual labour, professionals)

Labour practices (e.g., working hours, role definitions)

LO3 Explore strategies for construction procurement that address economic, social, environmental and political challenges

Procurement types

Traditional

Design-Build (e.g., single-stage, two-stage)

Management

Private Finance Initiative/Public-Private Partnership (e.g., Design-Build-Operate (DBO), Build-Own-Operate-Transfer (BOOT))

Other (e.g., framework agreements, engineering procurement and construction (EPC), fast-track construction, partnering, prime contracting)

Procurement in response to

Economic factors (e.g., cost, time, ROI)

Social factors (e.g., stakeholders (individual, public, private, institutional), employment, environmental factors, political factors)

LO4 **Present an analysis of an existing or proposed development in relation to the economic, social and political factors influencing its success**

Presentation type

Report

Audio/visual

Audience

Professional

Non-professional

Peer

Project/development type

Residential

Commercial

Institutional

Procurement

Procurement route

Contract type

Drivers/influences

Economic

Political

Social

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the political, economic, social and environmental factors that influence the construction industry		
P1 Explain the ways that economic models may influence construction projects. **P2** Describe the relationship between political decisions and construction costs.	**M1** Analyse the impact of the economic 'market' on construction costs.	**D1** Critically evaluate the ways that global economics influences construction.
LO2 Assess the relationship between economic factors, material and labour costs		
P3 Review a set of general arrangement drawings, selected details and door/window schedules to determine the factors that influence material and labour costs. **P4** Produce an outline bill of quantities related to a given project.	**M2** Compose a Schedule of Works.	**D2** Critically analyse the dynamic relationships between material and labour costs with inflation.
LO3 Explore strategies for construction procurement that address economic, social, environmental and political challenges		
P5 Discuss the ways that different procurement routes respond to social, political, and economic drivers. **P6** Examine the relationship between procurement route and sustainability.	**M3** Analyse the influence of government policy on the procurement route for public projects.	

Pass	Merit	Distinction
LO4 Present an analysis of an existing or proposed development in relation to the economic, social and political factors influencing its success		
P7 Examine the ways in which a construction project responds to political, social and economic influences. **P8** Present the outcomes of the analysis of a construction project.	**M4** Justify an approach to presenting project analysis in meeting audience needs.	**D3** Present a critique of a project's procurement route in response to political, social and economic drivers.

Recommended Resources

Print resources

GRUNEBERG, S., FRANCIS, N. (2019), *The Economics of Construction, (Economics of Big Business)*, Agenda Publishing

HIGHAM, A., BRIDGE, C., FARRELL, P. (2016), *Project Finance for Construction*, Routledge

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

MYERS, D. (2016), *Construction Economics*, Taylor & Francis

STAIGER, R. (2015), *Foundations of Real Estate Financial Modelling*, Routledge

Web resources

https://www.designingbuildings.co.uk	**Building Cost models** (Article)
https://www.designingbuildings.co.uk	**Designing Buildings Wiki – How does the state of the economy influence the construction industry?** (Article)
https://www.designingbuildings.co.uk	**Designing Buildings Wiki – Microeconomics** (Article)
https://www.designingbuildings.co.uk	**Designing Buildings Wiki – Property Development Finance** (Article)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 25: Quantity Surveying Practice
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 29: Contracts & Management
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 54: Advanced Quantity Surveying Practice.

Unit 24: Principles of Off-site Construction

Level: 4

Credits: 15

Ofqual Code: Y/618/8103

Introduction

Construction in the 21st century is (in most cases) still carried out along the same principles as medieval construction. Large amounts of material are delivered to a building site where weather conditions and physical constraints can cause not just delays and defects but often unattractive working conditions. Off-site construction offers a range of potential benefits for increasing the efficiency, accuracy and quality of the end product.

In this unit, students will explore different approaches to off-site construction, focusing on building development and delivery. This includes modular construction, factory construction, automation and robotics, and 3D printing. Students will consider the way in which off-site processes and technologies may influence building design and delivery.

By the end of this unit, students will be able to assess potential options for off-site production and develop design and manufacturing strategies to enable building delivery.

Learning Outcomes

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

LO1 Explain the different forms of off-site construction and how they provide potential benefits for building production and delivery

LO2 Explore the ways that design is influenced by different forms of off-site construction

LO3 Discuss the benefits of a selected off-site construction method or technology in relation to efficiency, sustainability and cost of project delivery

LO4 Present a proposal for off-site construction of a given building type, highlighting the benefits of the method for quality, efficiency and cost of delivery.

Essential Content

LO1 **Explain the different forms of off-site construction and how they provide potential benefits for building production and delivery**

Forms of off-site construction

Component based

Panelised

Unit based

Delivery benefits

Affordability

Sustainability

Reduced material waste

Reduced material transport cost

Better building fabric control/tolerance

Production benefits

Quality control

Speed and efficiency of manufacture and assembly

Factory controlled working conditions

Health and safety

Economies of scale (e.g., labour, plant hire, material, waste, purchasing)

Automation

LO2 **Explore the ways that design is influenced by different forms of off-site construction**

Non-volumetric pre-assembly

Pre-assemble units/elements

Pre-assembled cladding panels

Precast concrete sections

Pre-assemble structural steelwork

Volumetric pre-assembly

Complete volumetric units

Factory finished units (e.g., bathroom pods, kitchen pods, plant rooms, etc.)
3-D printing

Volumetric modular units

Cross Laminated Timber (CLT)

Steel Framing Systems (SFS)

Re-purposing other modular units (e.g., grain silos, shipping containers)

Panelised off-site construction

Timber framed panels

Steel framing systems

Sandwich panel systems

Pre-cast concrete panels/sections

LO3 **Discuss the benefits of a selected off-site construction method or technology in relation to efficiency, sustainability and cost of project delivery**

Efficiency

Time on-site

Consistent and controlled quality

Economies of scale (e.g., labour, materials, purchasing)

Waste minimisation

Safety (e.g., better control of working conditions, limited time on-site)

Sustainability

Social (e.g., responding to changing demographics, flexibility of building use)

Economic (e.g., potential for lower building cost, better building fabric resulting in lower operating costs)

Environmental (e.g., reduced carbon emissions, reduced transport, more efficient use of materials)

Cultural

Cost of delivery

Potential benefits of offsite construction

Speed of delivery

Reduced time and labour on-site

Economies of scale

Economies of multi-skilled labour

Potential challenges of offsite construction

Future labour shortage (growing skills gaps)

Factory set-up costs (e.g., location, access to labour)

LO4 **Present a proposal, for off-site construction of a given building type, highlighting the benefits of the method for quality, efficiency and cost of delivery**

Proposal

Site information

Site type (e.g., greenfield, brownfield, rural, urban)

Off site method (e.g., component-based, panelised, unit-based)

Justification

Quality

Efficiency

Cost

Presentation of proposal

Research

Proposal

Drawings (e.g., sketches, diagrams, technical information)

Data

Presentation type (e.g., audio-visual, written report, etc.)

Audience (e.g., specialist, non-specialist)

Feedback/reflection

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the different forms of off-site construction and how they provide potential benefits for building production and delivery		
P1 Explore the different forms of off-site construction. **P2** Discuss the benefits of off-site construction for building production and delivery.	**M1** Compare the benefits and challenges of different types of off-site construction.	**D1** Critically analyse the way in which a specific off-site construction method will support the achievement of design outcomes and cost-effective production.
LO2 Explore the ways that design is influenced by different forms of off-site construction		
P3 Discuss the relationship between design and construction. **P4** Explore the ways in which specific off-site construction methods may influence design decisions.	**M2** Evaluate the merits of a specific method of off-site construction to support a specific design outcome.	

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO3 Discuss the benefits of a selected off-site construction method or technology in relation to efficiency, sustainability and cost of project delivery</td><td rowspan="4">D2 Evaluate comments and feedback, in response to a presentation, to inform future off-site construction proposals.</td></tr>
<tr><td>P5 Explore a given brief to select a suitable method of off-site construction.

P6 Discuss how the selected off-site construction method achieves efficiency, sustainability and cost effectiveness for a given brief.</td><td>M3 Analyse the relationship between design, efficiency, sustainability and cost for a selected off-site construction method in meeting a given brief.</td></tr>
<tr><td colspan="2">LO4 Present a proposal, for off-site construction of a given building type, highlighting the benefits of the method for quality, efficiency and cost of delivery</td></tr>
<tr><td>P7 Prepare research, analysis and information necessary to support a proposal for off-site construction, in response to a given brief.

P8 Present, to a diverse audience, an off-site construction proposal, highlighting the achievement of quality, efficiency and cost effectiveness.</td><td>M4 Justify a position, in response to presentation comments, through the detailed explanation of a strategy.</td></tr>
</table>

Recommended Resources

Print resources

COTTERELL, J., DADEBY, A. (2012), *The Passivhaus Handbook: A practical guide to constructing and retrofitting buildings for ultra-low energy performance*, Green Books

DUFFY, A., ROGERS, M., AYOMPE, L. (2015), *Renewable Energy and Energy Efficiency*, John Wiley & Sons

GRINNELL, S. (2015), *Renewable Energy & Sustainable Design*, Cengage Learning

HAIRSTANS, R. (2017*), Building Offsite*, ARCA Media

HICKEY, T. (2014), *Construction Technology: Designing Sustainable Homes*, Gill Education

LAWSON, M., OGDEN, R., GOODIER, C. (2014), *Design in Modular Construction*, CRC Press

SINOPOLI, J. (2009), *Smart Buildings Systems for Architects, Owners and Builders*, Butterworth-Heinemann

Web resources

https://www.buildoffsite.com	**Build Offsite** (General Reference)
https://www.icevirtuallibrary.com	**ICE Virtual Library** (General Reference)
https://www.lboro.ac.uk	**Offsite Construction – Loughborough University** (General Reference)
https://www.trada.co.uk	**The Timber Research and Development Association** (Professional Body)
https://www.renewableenergycentre.co.uk	**The Renewable Energy Centre** (General Reference)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 15: Principles of Alternative Energy
- Unit 19: Principles of Structural Design
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling
- Unit 53: Advanced Off-site Construction.

Unit 25: Quantity Surveying Practice

Level: 4

Credits: 15

Ofqual Code: D/618/8135

Introduction

The quantity surveyor plays an important role in the administration of a contract for both the client and the main contractor. The client's appointed quantity surveyor is often known as the professional quantity surveyor (PQS) as they tend to be chartered. The internationally recognised quantity surveying associations are the Royal Institution of Chartered Surveyors (RICS), Chartered Institute of Building (CIOB) and the Chartered Institution of Civil Engineering Surveyors (CICES), as well as others.

The quantity surveyor plays an important role in the design and construction team. They are involved initially in the client's feasibility studies when a project requires to be budgeted so that the client is aware of the cost of a project. A design is then produced, based on the feasibility study, and the quantity surveyor supports the tendering and procurement of a main contractor to undertake the work. This may be via the use of a bill of quantities (BoQ) produced by the quantity surveyor or through a specification for the project.

The function of the quantity surveyor then moves on to the construction stage of a project. Here they are involved with the payments made to contractors from the client. This process is known as the valuation of the works and is undertaken on a regular time interval, or pre-determined stages of the project. The quantity surveyor will visit a site, measure the work produced to date and certify a payment for the client to make. Further functions of a quantity surveyor are to formulate the final costs for a client in the form of a final account. This may involve the resolution of any disputes and or claims made by the main contractor to a mutual agreement.

Learning Outcomes

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

LO1 Explain the role of the quantity surveyor

LO2 Explain the activities of a quantity surveyor in the pre-construction phases of a project

LO3 Assess the processes of quantity surveying during the construction phase of a project

LO4 Present a case study that considers the role and activities of a quantity surveyor for a given project.

Essential Content

LO1 **Explain the role of the quantity surveyor**

Types

Professional quantity surveyor (PQS)

Main contractor's quantity surveyor

Professional bodies and professional recognition

Advice and guidance provided by quantity surveyor

Financing projects (feasibility)

Procurement routes

Tendering procedures

Contract selection

Main contractor selection recommendations

Administrative responsibilities

Contracts

Budgeting

Cost control

Professional development

Identifying own development needs

Continuing Professional Development (CPD)

Supporting the development of others

Professional bodies and maintaining professional knowledge

Relationship with other professionals

Design team (e.g., architects, interior designers)

Consultants (e.g., engineers, project managers)

Construction team (e.g., contractors, sub-contractors, suppliers)

LO2 **Explain the activities of a quantity surveyor in the pre-construction phases of a project**

Feasibility

Strategic definition (e.g., procurement route selection, main contractor selection)

Preparation and brief (e.g., financial feasibility of the proposed project)

Comparison of designs

Cost value engineering

Revision of client's specifications to suit budgets

Costing of design revisions

Reconciliation of value engineering within the overall budget

Procurement

Procurement strategy during project phases (e.g., concept, development, technical design)

Contract selection

Change control procedures

Tendering activities

Preparation of documentation (e.g., specifications, contracts)

Updating information

Contract documentation (e.g., letters of intent, selection of suitable contracts, completion of contracts for signature by parties, filing and contract administration)

Contractor selection (e.g., background checks, financial checks, interviews)

Contractor negotiation and appointment

LO3 **Assess the processes of quantity surveying during the construction phase of a project**

Financial control

Valuations of work to date

Compilation of financial certificates

Predicted expenditure

Valuation of variations

Measurement against agreed rates

Dispute resolution

Administration of the contract in terms of conditions

Record keeping regarding claims

Site measurements and inspections

Agreement of claims

Resolution of disputes between main contractor and client

Valuations

Monthly valuations

Certification

Measurement of variations

Agreement of quotations

Variations to contract

Acceptance under contract terms

Pricing of variation against bill of quantities (BoQ) or rates

Dayworks

Offsets against contingencies

Final accounts

Omissions and additions account

Adjustment of provisional sums

Adjustment of prime cost sums

Measurement of variations

Calculation of final account sum

LO4 **Present a case study that considers the role and activities of a quantity surveyor for a given project**

Project type

Building (new or refurbishment)

Civil engineering/infrastructure project

Project budget

Initial client's budget

Revisions to a budget, as required

Procurement strategy

Type of procurement

Advantages and benefits of your procurement selection

Cost control

Aspects of cost control on your project

Control against the contract sum

Variations and how to accommodate these in final summaries

Contract administration

Communications between parties

Valuations and payments

Certification records

Case-study presentation type

Report

Audio-visual

Audience

Professional

Non-professional

Peer

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the role of the quantity surveyor		**D1** Analyse the professional status of a quantity surveyor in terms of the benefits that it brings to the role.
P1 Describe the different types of quantity surveyor and their role within a project. **P2** Discuss the way that a quantity surveyor may support a client through contracts and cost management.	**M1** Compare the roles of the professional quantity surveyor and the main contractor's quantity surveyor.	
LO2 Explain the activities of a quantity surveyor in the pre-construction phases of a project		**D2** Evaluate the role of the quantity surveyor in defining tender and procurement strategies.
P3 Describe the role of the quantity surveyor in the feasibility stage of a project. **P4** Illustrate ways in which cost control and value engineering contribute to the project budget.	**M2** Analyse the interactions between the design team and the quantity surveyor.	
LO3 Assess the processes of quantity surveying during the construction phase of a project		
P5 Describe the role of the quantity surveyor during the construction phase. **P6** Discuss the contract administration activities of a quantity surveyor during the construction phase.	**M3** Explain the relationship between financial control and valuation.	
LO4 Present a case study that considers the role and activities of a quantity surveyor for a given project		**D3** Evaluate the influence that a quantity surveyor may have on the outcome of a given project, in relation to budget, cost control and administration.
P7 Discuss the pre contract administration of a given project. **P8** Describe how a given project is financially controlled.	**M4** Explain how a client's budget for a given project can be controlled.	

Recommended Resources

Print resources

ASHWORTH, A., HOGG, K., HIGGS, C. (2013), *Willis's Practice and Procedure for the Quantity Surveyor*, John Wiley & Sons

PITTARD, S., SELL, P. (2017), *BIM and Quantity Surveying*, Routledge

SEELEY, I. (1997), *Quantity Surveying Practice*, Macmillan International Higher Education

Web resources

https://www.cices.org	**Chartered Institution of Civil Engineering Surveyors** (Professional Body)
https://www.rics.org	**Royal Institution of Chartered Surveyors** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 23: Construction Economics & Sustainability
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 39: Personal Professional Development
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 54: Advanced Quantity Surveying Practice.

Unit 26: Digital Applications for Building Information Modelling

Level: 4

Credits: 15

Ofqual Code: D/618/8104

Introduction

Building Information Modelling (BIM) and the use of data in the planning, construction and operation of built assets has become commonplace for both large and small projects. The ability to manage projects throughout their lifecycle, using a common data set, has the potential to impact on the built environment in numerous ways such as supporting efficiency, reducing costs and driving sustainability. However, for this to be achieved there is a need for the development of consistent, accurate and accessible data.

While BIM is, effectively, a process of information management through a project lifecycle, it is most often based on the use of digital applications to generate project data. In this, the model is central in the process of designing and producing information that will facilitate construction and, later, the operation of the built asset.

In this unit, students will explore the key processes in using digital applications to produce data and construction information that will enable the BIM process. Through completion of this unit, students may have the opportunity to achieve vendor certification in industry-standard Building Information Modelling systems.

Learning Outcomes

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

LO1 Discuss the role of model data in a BIM-enabled project

LO2 Model and modify common building elements for a given project

LO3 Generate 2D and 3D views of a building model to present key features of a given project

LO4 Assemble construction information using appropriate views, generated within a BIM application, for a given project.

Essential Content

LO1 Discuss the role of model data in a BIM-enabled project

Model features

Geometric model vs information model

Parametric modelling

'Intelligent' models

BIM project data

Project model

Asset Model

Common Data Environment

Collaboration

Model components

Grids

Levels

Walls

Doors

Windows

Substructures

Roofs

Structural elements

Mechanical elements

Tagging and categories

Model users and contributors

Client team

Design team

Cost management team (e.g., cost consultant, quantity surveyor)

Construction team

Facilities management team

LO2 **Model and modify common building elements for a given project**

Walls

Wall structure/layers

Wall materials

Wall alignment (e.g., inner face, outer face, centre line, structural face)

Joining walls (e.g., corner, intersection, ‘T’-joins)

Doors and windows

Door types

Window types

Door and window symbols

Generating schedules

Stairs

Stair layouts (e.g., straight, quarter-turn/’L-shaped’, winders, spiral, half-turn, 'U-shaped')

Stair elements (e.g., riser, tread, nosing, landings, stringers)

Stair construction (e.g., timber, concrete, steel)

Railings (e.g., railing material, railing height, building regulation requirements)

Ramps

Ramp layout (e.g., straight, quarter-turn, half-turn)

Ramp pitch (e.g., rise vs length, building regulation requirements)

Ramp construction (e.g., timber, concrete, steel)

Railings (e.g., railing material, railing height, building regulation requirements)

Floors

Floor construction (e.g., suspended timber, reinforced concrete, precast panels)

Floor layers (e.g., structure, finish surface, ceiling below)

Floor to wall junctions

Floor openings (e.g., stair openings, ramp openings)

Columns

Column grids

Column type (e.g., steel, reinforced concrete)

Column to floor junction

Structural elements

Columns (e.g., column grids, column construction, column to floor junctions)

Beams (e.g., beam types, materials)

Trusses (e.g., truss types, materials)

Landscape/topography

Site information (e.g., boundaries, contour lines)

Contour heights

Mechanical elements

Plant (e.g., boiler systems, air conditioning/air handling)

Ductwork

Pipework

Modifying common elements

Align

Offset

Mirror

Split (e.g., wall split, floor split)

Move

Copy

Rotate

Trim

Extend (e.g., extend to intersection, extend to corner, extend to boundary)

LO3 Generate 2D and 3D views of a building model to present key features of a given project

View features

Scale

Detail level

Visibility (e.g., background depth/view range, hidden elements, hiding tagged elements/categories, overriding standard visibility settings)

Hiding/isolating elements

View types

Plans (e.g., floor plan, ceiling plan, site plans, cut level above floor, amount of detail to include, visibility of material in cut elements)

Elevations (e.g., view depth to show background, interior and exterior elevations, furniture and fittings in interior elevations, visibility of materials)

Sections (e.g., building section, detail sections, level of detail, material visibility)

3D views (e.g., axonometric, perspective, exterior and interior 3D views, 3D detail views)

Renderings (e.g., materials, lighting, perspective view, managing rendering time)

LO4 Assemble construction information using appropriate views, generated within a BIM application, for a given project

Dimensions

Units

Terminators

Fonts and font sizes

Dimension strings

Angular dimensions

Annotations

Section markers

Elevation markers

Detail bubbles

Notes and leaders

Sheet views

Title blocks and project information

Sheet numbering

View scale

View titles/numbers

Schedules (e.g., door schedules, window schedules)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the role of model data in a BIM-enabled project		**D1** Evaluate the ways in which model data, developed within BIM applications, may ensure consistency of information and statutory compliance.
P1 Explain the role of data in a BIM-enabled project. **P2** Describe the key components in a model for a BIM-enabled project.	**M1** Assess the value of parametric modelling for generating data in a BIM-enabled project.	
LO2 Model and modify common building elements for a given project		
P3 Create common construction elements for a given project using industry-standard BIM applications. **P4** Undertake modifications to construction elements, in a BIM application, to meet the needs of a given project.	**M2** Analyse stairs, ramps and railings, generated within BIM-enabled applications, to ensure compliance with building regulations.	
LO3 Generate 2D and 3D views of a building model to present key features of a given project		**D2** Justify the selection of model views used in the production of construction information for a given project.
P5 Define plan, section and elevation views for a given project. **P6** Produce 3D rendered views of key features or details of a given project.	**M3** Adjust views to ensure the level of detail and depth are sufficient to show information required for a given project.	
LO4 Assemble construction information using appropriate views, generated within a BIM application, for a given project		
P7 Integrate dimensions, notes and annotations into model views to support construction information. **P8** Place model views into sheet views to provide construction information for a given project.	**M4** Review sheet views to ensure consistency of title blocks, sheet numbering and view scales.	

Recommended Resources

Print resources

BALLAST, D. (2009), *Architect's Handbook of Construction Detailing*, John Wiley & Sons

GARBER, R. (2014), *BIM Design*, John Wiley & Sons

INGRAM, J. (2020*), Understanding BIM*, Routledge

SACKS, R., EASTMAN, C., LEE, G., TEICHOLZ, P. (2018), *BIM Handbook*, John Wiley & Sons

Web resources

https://www.archdaily.com	**ArchDaily – What is BIM and Why Does it Seem to be Fundamental in the Current Architectural Design?** (Article)
https://www.autodesk.com	**Autodesk – What is BIM in construction?** (General Reference)
https://www.thenbs.com	**NBS – What is Building Information Modelling (BIM)?** (General Reference)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 20: Site Supervision & Operations
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 47: Advanced Building Information Modelling.

Unit 27: Law & Legal Frameworks in Quantity Surveying

Level: 4

Credits: 15

Ofqual Code: Y/618/8134

Introduction

The quantity surveyor must act in accordance with appropriate legislation for all stakeholders. This ensures that they take a fair, equal and consistent approach in their professional dealings with clients and main contractors.

Throughout the course of a project, a quantity surveyor will be called on to undertake different types of work in support of the specific stage of the project and the overall project goals. This will range from contract preparation and tendering, to cost management and, in some cases, mediation of disputes.

In this unit, students will become familiar with the key legal frameworks and processes that inform and govern the activities of quantity surveying.

Learning Outcomes

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

LO1 Discuss the legal context of a quantity surveyor

LO2 Explain the management of confidential data

LO3 Assess the quantity surveyor's role in contractual dispute mediation

LO4 Investigate property legislation in relation to quantity surveying.

Essential Content

LO1 **Discuss the legal context of a quantity surveyor**

The contractual position of a quantity surveyor

Contractual relationships (e.g., direct contract to a client, contracted to a main contractor, employed in quantity surveying practice, freelance/self-employed, bespoke contract)

Professional bodies (e.g., Royal Institution of Chartered Surveyors, Chartered Institution of Civil Engineering Surveyors)

Professional liability

Working relationships with stakeholders and consultants (e.g., project manager, architect, engineers, contractors, sub-contractors)

Legal context

Behaving in accordance with commercial trading legislation

Preparing contracts for authorisation and signing by parties

Processing payments and taxation requirements

Ensuring contractual time constraints are met (e.g., payment terms, completion dates etc.)

Protection of client and project confidential data and information

Complying with appropriate procurement legislation

Production of tax returns

Financial laws

Public procurement regulations for a country

Private procurement regulations

Local bylaws

Consumer legislation (e.g., purchase of goods and services, sale of goods and services, rental and lease of goods)

Insider trading legislation

Fraud law

Company law (e.g., employment legislation, employer liability)

Bribery acts

Money laundering legislation

International legislative agreements.

Building regulations

Health and safety

Local, regional and national building codes

LO2 Explain the management of confidential data

Types of data

As-built project data

Tendering and procurement values

Company trade accounts

Suppliers' and sub-contractors' data

Company financial accounts

Other financial data

Management of data

Legal protection of data (e.g., GDPR EU Regulations)

Local and international data protection legislation

Data manager roles

Legal ownership (e.g., architects' design drawings, client-supplied information)

Time periods for retention of data

Digital or paper retention

Digital security (e.g., firewalls, encryption, keychain and password protected systems)

Hierarchical access controls

How data is archived when no longer required to be retained

LO3 Assess the quantity surveyor's role in contractual dispute mediation

Arbitration

Professional arbitration through a professional association (e.g., RICS, CIOB, CICES, RIBA)

Acting as a mediator between parties to the dispute

Compiling a submission for arbitration as the main contractor's quantity surveyor

Compiling a submission for arbitration as the professional quantity surveyor (PQS)

Agreeing an arbitrator, if determined through contract terms

Agreeing a venue for arbitration

Arranging meetings between parties

Conducting meetings

Report writing/note taking

Arbitration summary agreed and issued

Adjudication

Appointment of arbitrator

Reference to any contract-named Building Disputes Tribunal adjudicator

Reference to local/national tribunal arrangements

Agreement of appointed adjudicator

Submissions to adjudicator by parties

Formal reviewing period of documentary evidence

Production of adjudication report

Release of report by party to the adjudication by payment

Court proceedings

Dispute between parties

Resolution using contract terms and conditions

Obtaining services of a solicitor/barrister

Formal court submission

Attending hearings

Reaching a verdict

Award

Compensation

Recovery of debt due

LO4 **Investigate property legislation in relation to quantity surveying**

Acquisition of land

Current use

Government/local authority zoning regarding housing

Planning permissions

Land registration searches

Procurement through auction

Private purchase

Anonymous bidding process

Direct approach by developer or through an agent

Government requirements to register land in owner’s name

Acquisition of land for public works processes and procedures

Compulsory purchase acquisition

Conveyance of title

Existing title deeds

Valuation of land

Agreement of purchase price

Searches

Land registration requirements

Conveyancing

Transfer of title upon payment

New deeds registered

Payment of any government taxes

Boundaries

Establishing boundary markers

Title deed drawings

Access and egress from land

Fence lines and ownership

Party walls, party structures

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the legal context of a quantity surveyor		**D1** Evaluate the legislative requirements in maintaining a fair and equal commercial operation.
P1 Describe the contractual position of a quantity surveyor. **P2** Explain the legal context of a quantity surveyor working directly for a client.	**M1** Analyse the legislation and regulations that a quantity surveyor must comply with in maintaining a legally neutral position.	
LO2 Explain the management of confidential data		**D2** Analyse the consequences of a data breach and the penalties that may be incurred.
P3 Describe the different types of confidential data that must be protected and secured. **P4** Illustrate the different ways to avoid data breaches.	**M2** Evaluate a contract in terms of what data has to be secured to comply with appropriate data protection laws.	
LO3 Assess the quantity surveyor's role in contractual dispute mediation		**D3** Justify the use of alternative resolution methods against taking court action in a dispute.
P5 Discuss the difference between arbitration and adjudication. **P6** Explain the role of a quantity surveyor in arbitration and adjudication.	**M3** Evaluate arbitration and adjudication in terms of their benefits to a client.	
LO4 Investigate property legislation in relation to quantity surveying		**D4** Evaluate the role of a quantity surveyor in the processes of land acquisition and conveyancing.
P7 Describe how land is acquired for built environment development purposes. **P8** Explain the processes associated with the conveyancing of land.	**M4** Analyse how legal ownership of land is defined.	

Recommended Resources

Print resources

ASHWORTH, A., HOGG, K., HIGGS, C. (2013), *Willis's Practice and Procedure for the Quantity Surveyor*, John Wiley & Sons

DIXON, M., GRIFFITHS, G., LEES, E. (2009), *Q&A Land Law 2009-2010*, Routledge

NOLAN-HALEY, J. (2001), *Alternative Dispute Resolution in a Nutshell*, West Academic

PICCARILLO, A. and PICCARILLO, T. (2017) *Conveyancing Guide*, CreateSpace Independent Publishing Platform.

Web resources

https://www.designingbuildings.co.uk	**Designing Buildings Wiki – Conveyancing** (General Reference)
https://www.designingbuildings.co.uk	**Designing Buildings Wiki – Dispute Resolution** (General Reference)
https://www.rics.org	**Royal Institution of Chartered Surveyors** (Professional Body)

Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 39: Personal Professional Development
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.

Unit 28: Group Project (Pearson-set)

Level: 5

Credits: 15

Ofqual Code: H/618/8105

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 also 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 in 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 and safety, project costing and Building Information Modelling (BIM).

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:

LO1 Assess individual and group skills to allocate roles within a collaborative team

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

LO3 Prepare tender documentation, undertaking work appropriate to a defined role within a team

LO4 Evaluate own work, and the work of others, in a collaborative team.

Essential Content

LO1 Assess individual and group skills to allocate roles within a collaborative team

Roles and responsibilities

Skills auditing

Evaluating personality and teams (e.g., Belbin Team Inventory, Myers Briggs Personality Type Indicator)

Human resources management

Core job dimensions (e.g., skill variety, task identity, task significance, autonomy, feedback)

Job design (e.g., 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

Client requirements

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 and safety legislation

Building Information Modelling (BIM)

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
LO1 Assess individual and group skills to allocate roles within a collaborative team		
P1 Evaluate own skills and the skills of others through skills auditing and review. **P2** Develop role descriptions and responsibilities within a team.	**M1** Discuss the allocation of roles within a collaborative team to meet overall project needs.	**D1** Justify the allocation of roles and responsibilities within a team, recognising individual skills and ambitions vs project requirements.
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		**D2** Critically evaluate the relationships between project planning and tender documentation, highlighting ways in which tender information responds to project planning.
P3 Develop a project plan to ensure successful achievement of completed project. **P4** Illustrate resource planning (both physical and human) as well as time planning.	**M2** Interpret events and activities in a project plan to indicate milestones and risks.	
LO3 Prepare tender documentation, undertaking work appropriate to a defined role within a team		
P5 Develop construction drawings and specifications. **P6** Prepare a cost plan. **P7** Produce a pre-construction health and safety method statement.	**M3** Evaluate the ways in which Building Information Modelling (BIM) can provide greater efficiency in collaborative preparation of tender documentation.	
LO4 Evaluate own work, and the work of others, in a collaborative team		
P8 Undertake a continual review of own work, recording it throughout the project. **P9** Review own working practices in relation to that of other members of the team, identifying areas of good practice.	**M4** Evaluate own personality profile in relation to own working practices.	**D3** Critically evaluate the success of a project by considering individual and group working practices in relation to assigned roles and personality profiles.

Recommended Resources

Print resources

BALDWIN, A., BORDOLI, D. (2014), *Handbook for Construction Planning and Scheduling*, John Wiley & Sons

BELBIN, R. (2010), *Team Roles at Work*, Routledge

BENNETT, J., PEACE, S. (2007), *Partnering in the Construction Industry*, Routledge

BOUCHLAGHEM, D. (2012), *Collaborative Working in Construction*, Routledge

CIOB (THE CHARTERED INSTITUTE OF BUILDING) (2010), *Guide to Good Practice in the Management of Time in Complex Projects*, John Wiley & Sons

KELLY, J., MALE, S. (2003), *Value Management in Design and Construction*, Routledge

LOOSEMORE, M., DAINTY, A., LINGARD, H. (2003), *Human Resource Management in Construction Projects*, Routledge

MEIER, H., WYATT, D. (2008), *Construction Specifications*, Delmar Pub

POTTS, K., ANKRAH, N. (2014), *Construction Cost Management*, Routledge

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 30: Project Management
- Unit 39: Personal Professional Development.

Unit 29: Contracts & Management

Level: 5

Credits: 15

Ofqual Code: K/618/8106

Introduction

The successful management of a project relies on 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 give students a working knowledge of contracts so that they can manage a project team in accordance with the agreed terms and conditions of the contract. The principal 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 able to run and administer a project using the contract terms and conditions that have been agreed between a client and the main contractor. Students will also have the fundamental knowledge and skills to progress to a higher level of study.

Learning Outcomes

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

LO1 Discuss the different stakeholders and contractual relationships that may develop during a construction project

LO2 Explain the criteria that inform the selection of a construction contract

LO3 Examine different forms of standard construction contract and their application to built environment projects

LO4 Prepare an appropriate form of contract for a selected project, specifying the terms and conditions.

Essential Content

LO1 Discuss the different stakeholders and contractual relationships that may develop during a construction project

Stakeholders

Client/developer

Users

Finance/investment organisations

Consultants

Architects/designers

Engineers

Cost consultants

Project managers

Other consultants

Contractors

Main/general contractor

Sub-contractors

Manufacturers/suppliers

Novation

Procurement route

Traditional

Design and build

Admeasure

Construction management

Contractor led

Design build finance and operate (e.g., Public Private Partnership, Private Finance Initiative, Design Build Operate)

Framework agreements

Engineering procurement and construction contract (EPC)

Engineering procurement and construction management contract (EPCM)

Relationships within different contract types

LO2 Explain the criteria that inform the selection of a construction contract

Project factors

Project type (e.g., residential, commercial, industrial)

Nature of works (e.g., maintenance, capital works)

Client type (e.g., private, commercial, institutional, government)

Client information requirements (e.g., BIM requirements, data requirements)

Size of project

Value of project

Complexity of project

Knowledge and expertise of the employer or client

Location

Contract selection factors

Time (e.g., quick start and shorter completion date)

Cost (e.g., lump sum or re-measured costs against a schedule of rates)

Quality (e.g., materials and workmanship defined in specification)

Level of risk to be apportioned across all stakeholders

Client and main contractor balance of risk

Form of pricing (e.g., fixed price, variable price)

Design responsibility (e.g., architect design, contractor design)

Warranties and guarantees required

Basis of contract sum and payment options (e.g., phased, monthly)

Employer's control over sub-contractors (e.g., nominated, named, novated)

LO3 Examine different forms of standard construction contract and their application to built environment projects

Contract information/documents

Contract agreement

Scope of work definition

General conditions

Special conditions

Cost information (e.g., bill of quantities)

Work schedule

Drawings/data

Specifications

Insurance requirements

The Joints Contracts Tribunal (JCT) Suite of Contracts

Traditional (e.g., 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) (e.g., JCT Standard Building Contract 2011 (the 'with Approximate Quantities' version), JCT Measured Term Contract 2011)

Design and Build (e.g., JCT Design and Build Contract 2011, JCT Major Project Construction Contract 2011)

Construction Management (e.g., JCT Construction Management Appointment 2011, JCT Management Building Contract 2011)

Partnering (e.g., JCT-Constructing Excellence Contract 2011, PPC2000 (2013 edition))

The New Engineering Contract (NEC) suite

New Engineering Contract (NEC3)

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 (e.g., ICC Minor Works Version 2011, GC/Works series)

LO4 **Prepare an appropriate form of contract for a selected 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)

Supply chain

Supply chain management (e.g., nominated, named and other sub-contractors)

Manufacturers/suppliers contract conditions (e.g., tendering arrangements, information requirements, main contract implications, forms and agreement)

Sub-contractors contract conditions (e.g., 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 (e.g., certificate of making good defects, defects liability period)

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
LO1 Discuss the different stakeholders and contractual relationships that may develop during a construction project		**D1** Evaluate the risks associated with construction projects and how contracts manage risk for the parties involved.
P1 Explain the different stakeholders involved in a publicly financed project. **P2** Illustrate the contractual relationships that may exist in a given construction project.	**M1** Analyse the different relationships between contractor, client and consultants in a range of procurement routes.	
LO2 Explain the criteria that inform the selection of a construction contract		
P3 Discuss the relationship between project size, type and complexity on contract selection. **P4** Explore how time, cost and quality are managed through a construction contract.	**M2** Assess the way in which a contract supports the assurance of quality through warranties and guarantees.	
LO3 Examine different forms of standard construction contract and their application to built environment projects		**D2** Justify the selection and preparation of a standard form of construction contract in ensuring quality of the project and managing liability.
P5 Discuss standard forms of contract for building and infrastructure projects. **P6** Explain how contract information/documents support a standard form of contract.	**M3** Compare forms of standard contracts in terms of their applicability for a given project.	
LO4 Prepare an appropriate form of contract for a selected project, specifying the terms and conditions		
P7 Revise a standard form of contract to meet the requirements of a client/stakeholder group. **P8** Explain the rationale for defining selected terms and conditions in the preparation of a contract.	**M4** Discuss how collaboration between contractors and sub-contractors influences contractual arrangements.	

Recommended Resources

Print resources

CHAPPELL, D. (2020), *Construction Contracts*, Routledge

CHAPPELL, D. (2017), *Understanding JCT Standard Building Contracts*, Routledge

GODWIN, W. (2012), *International Construction Contracts*, John Wiley & Sons

HUGHES, W., CHAMPION, R., MURDOCH, J. (2007), *Construction Contracts*, Routledge

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
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- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 47: Advanced Building Information Modelling
- Unit 52: Advanced Housing Design & Specification
- Unit 54: Advanced Quantity Surveying Practice.

Unit 30: Project Management

Level: 5

Credits: 15

Ofqual Code: R/618/8133

Introduction

Management is a 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. In doing so, they will develop transferable skills as well as equipping themselves with industry-standard tools to work as effective members of a project management team.

Learning Outcomes

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

LO1 Discuss the theory and practice of project management and the context of the profession

LO2 Explain the roles, relationships and management of stakeholders in a construction project

LO3 Describe the activities of a project manager through the different phases of a construction project

LO4 Present a project management strategy for a given construction project.

Essential Content

LO1 **Discuss the theory and practice of project management and the context of the profession**

Project management

Definition of a project

The purpose of project management

The role of the Project Manager (e.g., responsibilities, attributes, competencies)

Project management vs construction management

Key concepts

Project goal

Resources (e.g., human, physical, data, scarcity, sustainability)

Timeline

Dependency

Milestones

Risks

Success

Professional recognition

Association for Project Management (APM)

Project Management Institute (PMI)

International Project Management Association (IPMA)

Green Project Management (GPM)

Others

Standards

PMI – Project Management Body of Knowledge (PMBOK Guide)

APM – Body of Knowledge

IPMA – Project Excellence Baseline (PEB)

GPM – Projects Integrating Sustainable Methods (PRISM)

ISO Standards (e.g., ISO 9000, ISO 10006:2003)

Others

Project management methodologies

Gantt charts

Critical Path Method (CPM)

Program Evaluation and Review Technique (PERT)

PRINCE2 (Projects in Controlled Environments)

Other (e.g., Agile, Lean, Scrum)

LO2 **Explain the roles, relationships and management of stakeholders in a construction project**

Definition of 'stakeholder'

'individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion.' (Project Management Institute, 2001)

Internal stakeholders

Investors (e.g., banks, shareholders)

Client

Consultants (e.g., architects, designers, engineers, cost consultants)

Contractors (e.g., main contractor, sub-contractors, suppliers)

Management (e.g., facilities managers, operators)

External stakeholders

Users (e.g., residents, occupiers)

Others (e.g., local government, general public, statutory agencies)

Stakeholder relationships

Contractual relationships

Financial relationships

Statutory relationships (e.g., statutory bodies, government bodies)

Moral/ethical relationships (e.g., professional bodies, equality and diversity, codes of conduct)

Stakeholder management

Stakeholders' power and interests

Monitoring stakeholder views

Communicating project information (e.g., keeping stakeholders informed)

Managing conflicts

LO3 **Describe the activities of a project manager through the different phases of a construction project**

Construction project process models

RIBA Plan of Work

OGC Gateway

Designing Building Wiki Project Plans

Other

Project initiation

Working with/appointment of consultants (e.g., architects, engineers, cost consultants)

Feasibility

Project planning

Scope statement and documentation

Project goals (e.g., SMART goals, CLEAR goals)

Work breakdown (e.g., milestones, dependencies)

Communication plan (e.g., information sharing, data sharing)

Risk management plan

Project execution

Assigning resources

Setting up tracking

Updating plans

Modifying plans

BIM in project management

Project monitoring

Concurrent with project execution

Measuring progress (e.g., time, potential delays, costs)

Project reporting (e.g., progress, cost, quality, material use, sustainability)

Health and safety (e.g., monitoring, notifying)

Project closure

Project completion

Snagging lists/punch lists

Final project evaluation

LO4 **Present a project management strategy for a given construction project**

Project type (e.g., residential, commercial, industrial, cultural)

Project stakeholders

Project management strategy

Scope

Goals

Timeline (e.g., Gantt chart, dependencies, milestones)

Resources (e.g., physical, materials, human)

Communications (e.g., information requirements, BIM data)

Presentation

Format (e.g., report, audio-visual)

Material (e.g., graphical, written, data)

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the theory and practice of project management and the context of the profession</td><td rowspan="4">D1 Analyse the way that different project management methodologies may address stakeholder interests in a construction project.</td></tr>
<tr><td>P1 Explain the function and benefits of project management for construction projects.

P2 Describe the role of professional bodies and standards in project management.</td><td>M1 Compare different project management concepts and standards, and their potential to support sustainability.</td></tr>
<tr><td colspan="2">LO2 Explain the roles, relationships and management of stakeholders in a construction project</td></tr>
<tr><td>P3 Discuss the different parties that may be considered internal and external stakeholders in a construction project.

P4 Assess the different types of stakeholder relationships in a construction project.</td><td>M2 Assess the power and interests of different stakeholders in a construction project and their influence on the management of the project.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Describe the activities of a project manager through the different phases of a construction project		
P5 Explain the role of a project manager through the different phases of a construction project. **P6** Discuss the role of the project manager during the construction phase, including health and safety requirements.	**M3** Illustrate how project management activities may map to an overall model of a construction project process.	**D2** Justify an approach to project management for a given construction project in supporting achievement of project goals.
LO4 Present a project management strategy for a given construction project		
P7 Define the project scope and goals for given construction project. **P8** Present a project management strategy that integrates project milestones, dependencies, resources and communication requirements.	**M4** Analyse the relationship between project goals, timeline and resources for a given construction project.	

Recommended Resources

Print resources

AXELOS (2018), *Directing Successful Projects with PRINCE2®*, Tso, the Stationery Office

CIOB (THE CHARTERED INSTITUTE OF BUILDING) (2008), *Code of Practice for Project Management for Construction and Development*, John Wiley & Sons

FEWINGS, P. (2013), *Construction Project Management*, Routledge

PROJECT MANAGEMENT INSTITUTE (2017), *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Sixth Edition*, Project Management Institute

SEARS, S., SEARS, G., CLOUGH, R., ROUNDS, J., SEGNER, R. (2015), *Construction Project Management*, John Wiley & Sons

Web resources

https://www.apm.org.uk	**Association for Project Management (APM)** (Professional Body)
https://www.prince2.com	**Prince2** (General Reference)
https://www.pmi.org	**Project Management Institute** (Professional Body)

Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 13: Building Information Modelling
- Unit 20: Site Supervision & Operations
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 43: Advanced Surveying & Measurement
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.

Unit 31: Advanced Structural Design

Level: 5

Credits: 15

Ofqual Code: M/618/8107

Introduction

With the development of new materials and processes, along with technologies that allow us to design and model more complex structures, the influence on structural design has become increasingly challenging. The ability to conceive and accurately model complex buildings, bridges, roads and other types of structure, pushes both the aesthetic and technical envelope in which structural and civil engineers now operate.

In managing the design and construction of modern structures, the civil or structural engineer must be able to carry out increasingly complex calculations, dealing with dynamic conditions, while maintaining an awareness of the overall design intention.

Extending areas of study from *Unit 19: 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:

LO1 Explain strategies to resist deflection due to wind loadings on fixed structures

LO2 Determine bending, shear and deflection for complex support conditions

LO3 Design complex columns and piled foundations based on calculation

LO4 Explore the design of tensile structures.

Essential Content

LO1 Explain strategies to resist deflection due to wind loadings on fixed structures

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 (BIM)

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
LO1 Explain strategies to resist deflection due to wind loadings on fixed structures		
P1 Calculate wind loads on fixed structures. **P2** Discuss methods to resist or manage wind loading.	**M1** Analyse the relationship between building form and wind loading.	**D1** Calculate and size the type of lateral stiffening required to resist wind loading for a given structure.
LO2 Determine bending, shear and deflection for complex support conditions		
P3 Calculate bending and shear in complex support conditions. **P4** Determine deflection in complex support conditions.	**M2** Evaluate structural connections in relation to complex support conditions.	**D2** Critically analyse the use of different materials to determine their structural efficiency in managing bending, shear and deflection.
LO3 Design complex columns and piled foundations based on calculation		
P5 Calculate the axial load-carrying capacity of complex columns, with eccentric loading and reinforced concrete piled foundations. **P6** Prepare design information for a structure utilising piled foundations and steel columns.	**M3** Discuss the benefits of using Building Information Modelling (BIM) in the structural design workflow.	**D3** Assess the most effective foundation type for a given scenario in terms of ease and speed of construction, economics, safety and environmental factors.
LO4 Explore the design of tensile structures		
P7 Discuss the differences between types of tensile structures. **P8** Design a simple tensile structure for a given scenario.	**M4** Compare tensile structural solutions to a given scenario.	**D4** Using research and calculations, justify the choice of a tensile structure solution for a given scenario.

Recommended Resources

Print resources

COBB, F. (2020), *Structural Engineer's Pocket Book British Standards Edition,* CRC Press

HULSE, R., CAIN, J. (2009), *Structural Mechanics: Worked Examples*, Macmillan International Higher Education

MCKENZIE, W. (2015), *Design of Structural Elements,* Macmillan International Higher Education

MOSLEY, W., HULSE, R., BUNGEY, J. (2012), *Reinforced Concrete Design*, Macmillan International Higher Education

NAGEIM, H., DURKA, F. (2003), *Structural Mechanics*, Pearson Education

OZELTON, E., BAIRD, J. (2008), *Timber Designers' Manual*, John Wiley & Sons

REYNOLDS, C., STEEDMAN, J., THRELFALL, A. (2007), *Reinforced Concrete Designer's Handbook*, Eleventh Edition, CRC Press

SEWARD, D. (2014), *Understanding Structures*, Macmillan International Higher Education

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 13: Building Information Modelling
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 34: Further Mathematics for Construction
- Unit 41: Highway Engineering
- Unit 42: Hydraulics
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling.

Unit 32: Advanced Construction Drawing & Detailing

Level: 5

Credits: 15

Ofqual Code: T/618/8108

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 in all sectors of the industry.

The aim of this unit is to give students an in-depth consideration of the ways that construction information is created, managed and shared throughout the lifecycle of a built asset. As well as understanding the different types of information required for complex projects, students will explore the development and use of standards to ensure consistency and interoperability of the data captured and shared, both in a geometric and non-geometric fashion.

In this unit, students will engage in the ways that construction drawing and detailing have evolved. They will 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:

LO1 Explore the methods to ensure consistent development and management of construction information

LO2 Examine the relationship between CAD and BIM data in the production and management of construction information

LO3 Discuss the types of information required throughout the lifecycle of a construction project

LO4 Prepare an information package for a given construction project.

Essential Content

LO1 **Explore the methods to ensure consistent development and management of construction information**

Standards

Office standards (e.g., drawing templates, sheet formats, hatching)

Industry standards (e.g., file formats, information packages

Classification systems (e.g., Uniclass, Omniclass)

Standard and open data formats (e.g., DWG, DXF, IFC)

Common Arrangement of Works (CAWS)

BIM standards (e.g., ISO 19650-1, ISO 19650-2, ISO 19650-3, ISO 19650-5)

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)

Specifications

Specification types (e.g., performance specification, prescriptive specification, technical specification, outline specification)

Standard specifications (e.g., NBS, MasterFormat)

Bills of quantities (BOQ)

Information coordination and communication

Information checking (e.g., drawing review, clash checking, document checking)

Coordination (e.g., specification with drawings, details with specification, schedules with specification/drawings)

Transmittal (e.g., ‘paper-based’, digital)

Information sharing systems (e.g., shared servers, cloud-based, commercial products)

LO2 Examine the relationship between CAD and BIM data in the production and management of construction information

CAD

Graphic (2D/3D) representation of project geometry

Benefits (e.g., speed of information production, low learning curve)

Challenges (e.g., only graphical/geometric, ‘information’ is in other documentation, manual coordination)

BIM

Detailed information about ‘assets’

‘Intelligent’ model data (e.g., materials, assemblies, costing info)

Benefits (e.g., project data can be within a ‘single model’, inherent coordination, supports project process, data enables multiple stakeholders)

Challenges (e.g., steep learning curve, overly complex for small projects, requires financial/training investment)

Linking CAD and BIM (e.g., BIM for overall coordination, CAD for detail drawings)

LO3 Discuss the types of information required throughout the lifecycle of a construction project

Strategic definition

Client requirements

Business case

Project risks

Preparation and briefing

Site information (e.g., survey data, soil information, site access)

Budget information

Project programme

Sustainability outcomes

Information requirements

Concept design

Initial design drawings/models

Initial engineering drawings/models

Initial cost plans

Outline specification

Planning application(s)

Spatial coordination

Design studies

Architectural and engineering information

Spatially coordinated design

Technical design

Construction information (general arrangement, details)

Final specifications

Construction phase plan

Building regulation application(s)

Contract information

Bills of quantities/specifications

Construction information (based on approach to tender)

Manufacturing and construction

Health and safety file

Fire safety information

Project manual (e.g., systems documentation, maintenance information)

Defects list

Handover and post-occupancy

Final health and safety file

Final fire safety information

Final building manual

'As-built' information (e.g., 'As-built' drawings, final Asset Information Model, BIM data)

Effect of procurement route on project information production

Effectiveness of BIM in managing information throughout project phases

LO4 **Prepare an information package for a given construction project**

Project type (e.g., residential, commercial, industrial, infrastructure)

Client information

Project brief (e.g., needs, expectations)

Budget

Timescale

Consultant information

Survey information

Structural information

Building services information

Other

Coordinating consultant information

General arrangement drawings

Site plans

Floor plans

Building sections

Elevations

Detail drawings

Wall details

Roof details

Window details

Door details

Schedules

Door schedules

Window schedules

Finish schedules

Other

Specifications

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore the methods to ensure consistent development and management of construction information</td><td rowspan="5">D1 Evaluate the importance of CAD and BIM standards to ensuring effective production and management of construction information.</td></tr>
<tr><td>P1 Discuss the importance of defining office standards to create and manage construction information.

P2 Explain the use of industry standards in the preparation of drawings and specifications.</td><td>M1 Analyse the methods available to support the effective coordination and sharing of construction information.</td></tr>
<tr><td colspan="2">LO2 Examine the relationship between CAD and BIM data in the production and management of construction information</td></tr>
<tr><td>P3 Explain the difference between CAD and BIM for generating and managing construction information.
P4 Discuss the benefits and challenges of CAD and BIM for the production and management of construction information.</td><td>M2 Compare the effectiveness of BIM and CAD for producing different types of construction information.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Discuss the types of information required throughout the lifecycle of a construction project		**D2** Evaluate the ways in which appropriate use of BIM and CAD tools may provide efficient production and management of information throughout the different phases of a project.
P5 Explain the types of information required at different stages of a construction project. **P6** Describe the purpose of information in the handover and post-occupancy phase that ensures ongoing health and safety.	**M3** Analyse how information requirements are informed by the choice of procurement route for a project.	
LO4 Prepare an information package for a given construction project		
P7 Review project type, client and consultant information to inform development of construction information package. **P8** Produce a required construction information package, using industry-standard CAD/BIM tools.	**M4** Justify the use of CAD or BIM tools in the production of different types of construction information for a given project.	

Recommended Resources

Print resources

BALLAST, D. (2009), *Architect's Handbook of Construction Detailing*, John Wiley & Sons

BEST, R., VALENCE, G. (2007*), Design and Construction*, Routledge

CROTTY, R. (2013), *The Impact of Building Information Modelling*, Routledge

PORT, S. (2012), *The Management of CAD for Construction*, Springer

SACKS, R., EASTMAN, C., LEE, G., TEICHOLZ, P. (2018), *BIM Handbook, John Wiley & Sons*

YEE, R. (2012), *Architectural Drawing*, John Wiley & Sons

Web resources

https://www.theb1m.com	**The B1M** (General Reference)
https://www.bimtaskgroup.org	**The BIM Task Group** (General Reference)
https://www.bimtaskgroup.org	**The BIM Task Group – 'COBie UK 2012'** (General Reference)
https://www.thenbs.com	**NBS – 'BIM (Building Information Modelling)'** (General Reference)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 47: Advanced Building Information Modelling.

Unit 33: Construction Technology for Complex Buildings Projects

Level: 5

Credits: 15

Ofqual Code: A/618/8109

Introduction

This unit focuses on the erection of buildings with complex requirements through the use of modern systems and methods of construction. Students will analyse the principles of buildability in terms of health and safety, efficiency, economy, sustainability and quality. 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 give students a thorough understanding of 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 is placed on the consideration of sustainability and health and safety in the construction of complex structures.

On successful completion of this unit, students will have applied suitable strategies, processes and methods of construction to meet prevailing conditions. They will be able to justify selected materials and construction methods used in complex buildings against set criteria and choose systems to facilitate alternative uses of buildings.

Learning Outcomes

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

LO1 Discuss the characteristics of complex construction projects and their challenges

LO2 Define strategy for the preparation, materials and substructures for a given large-scale construction project

LO3 Develop an information package for the superstructure, building services and fire safety of a given large-scale construction project

LO4 Propose solutions that meet the requirements for safe demolition and disposal of materials for a large-scale construction project.

Essential Content

LO1 **Discuss the characteristics of complex construction projects and their challenges**

High rise buildings (e.g., multi-occupancy residential, hotels, office buildings)

Substructure (e.g., depth requirements, soil stability, hydrostatic pressure)

Wind-loading and vertical stiffness

Vertical circulation and emergency escape

Goods delivery, waste disposal

Working conditions (e.g., working at height)

Medical buildings (e.g., hospitals, laboratories)

Hygiene (e.g., materials, maintenance)

Isolation (e.g., maintaining separation between contamination areas, air pressure systems, air filtration)

Specialist services (e.g., oxygen supply/distribution, emergency power systems, clean rooms)

Vehicle access (e.g., ambulance areas, helipads)

Commercial buildings (e.g., shopping centres, multi-use office/commercial)

Managing human traffic

Goods delivery, waste disposal

Complex building regulations (e.g., different uses, conflicting requirements)

Parking requirements

Cultural buildings (e.g., museums, concert halls, stadiums)

Acoustics (e.g., materials, acoustic separation, reverberation)

Security (e.g., protecting museum assets, managing large crowds)

Fire safety (e.g., means of escape for large groups)

Residential buildings (e.g., single occupancy (houses), multi-occupancy (aparment buildings), specialist residential (elderly care, sheltered accommodation, etc.))

Industrial buildings (e.g., factories, production halls and large distribution centres)

Acoustics (e.g., managing loud machinery noise, controlling breakout noise)

Equipment load (e.g., fixed equipment, mobile equipment, floor loading, cranes, gantries)

Dealing with rainwater (e.g., large roof areas, large hardscape areas)

Long-span structures

Environmental impact (e.g., construction impact, operational impact, emissions)

Electrical loads (e.g., high voltage requirements, substations, safety)

Transport building (e.g., airports, rail terminals, underground/subway stations, seaports)

Human traffic (e.g., separating incoming and outgoing passengers, restricted areas)

Vibration

Security

Long-span structures

Maintenance

Infrastructure (e.g., road/highway junctions/interchanges, rail bridges, large-span bridges, tunnels)

Environmental impact (e.g., local environment, material supply and use)

Long span structures

Human safety

Working conditions (e.g., working with active traffic, working at height)

Public services buildings (e.g., police stations, prisons, fire stations)

Separation of areas (e.g., accessible by general public vs secure)

Security

Specialist equipment requirements

Utilities (e.g., power stations, electrical distribution structures, dams)

Environmental impact (e.g., local environment, emissions, waste)

Safety (e.g., working with high voltage, pressure vessels, working at height)

Sustainability

Environmental (e.g., environmental impact, material use, material scarcity, CO2 emissions, noise pollution)

Social (e.g., impact on local community, demographics)

Economic (e.g., job creation, local disruption during construction)

Cultural (e.g., local history, archaeology, changing demographics)

LO2 **Define strategy for the preparation, materials and substructures for a given large-scale construction project**

Existing site conditions

Soil type

Bearing capacity

Water table

Seismic activity

Project requirements

Project type

Access

Superstructure proposal

Drainage (e.g., roof drainage, site drainage, sustainable urban draining systems (SUDS))

Subsurface services (e.g., electrical, water, sewerage)

Site preparation

Dewatering

Soil stabilisation

Foundation type and location (e.g., piling locations, materials)

Equipment and plant requirements

Statutory requirements

Health and safety (e.g., method statements, risk assessments)

Site safety certifications

Site staff certifications

Building regulations

LO3 **Develop an information package for the superstructure, building services and fire safety of a given large-scale construction project**

Superstructure

Managing loads and movement (e.g., wind loading, live loads, dead loads, thermal expansion)

Primary structure (e.g., concrete frame, steel frame, composite)

Secondary structure (e.g., curtain wall support, cladding support)

Roof structure (e.g., roof structure, roof decking, green roofs, roof drainage)

Floor construction (e.g., in-situ reinforced concrete, T-beam, hollow block, waffle slabs, precast, pre-stressed, post-tensions planks)

Column grid

Building services

Primary service supplies

Metering and access

Secondary and back-up power

Hot and cold water

Gas, electricity

Heating, ventilation and air conditioning

Communications

Waste removal

Fire safety

Statutory regulations

Sprinklers

Emergency lighting

Smoke handling

Refuge rooms

Escape stairs

Flame spread

Equipment and plant requirements

LO4 **Propose solutions that meet the requirements for safe demolition and disposal of materials for a large-scale construction project**

Demolition methods

Explosives

Hand demolition

Machine demolition

Other (e.g., gas expansion, hydraulic expansion, thermic reaction)

Construction information for demolition

As-built drawings

Building Manual (e.g., specifications, materials, maintenance records)

Building Information Modelling (BIM) asset data

Sustainability

Re-use or reclamation of standard components and assemblies

Specification of recyclable materials

Material separation

Material handling

Contaminated or dangerous material handling (e.g., asbestos, chemicals)

Material transport

Material disposal

Statutory regulations

Adjacent buildings

Health and safety regulations

Access for safe demolition

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the characteristics of complex construction projects and their challenges		
P1 Explain the structural needs of different types of complex construction projects. **P2** Describe the safety, security and sustainability needs of different types of complex construction projects.	**M1** Assess the relationship between structural solution and specialist technical requirements for different types of construction project.	**D1** Analyse how complex projects may require additional levels of health and safety.
LO2 Define strategy for the preparation, materials and substructures for a given large-scale construction project		
P3 Examine existing site conditions and project information to inform a strategy for site safety, preparation, materials and substructure. **P4** Develop a strategy that provides for the preparation of the site, safe working, suitable materials and substructure for a given complex building project.	**M2** Compare different approaches to material and construction method to determine their suitability for a given complex building project.	**D2** Evaluate the ways in which an approach to large-scale construction project superstructure informs the approach to fire safety.
LO3 Develop an information package for the superstructure, building services and fire safety of a given large-scale construction project		
P5 Compile drawings, specification and data to enable an information package for superstructure, building services and fire safety. **P6** Present an information package for a large-scale project, including superstructure, building services and fire safety.	**M3** Discuss the ways in which fire safety is addressed in large-scale projects to meet statutory regulations.	

Pass	Merit	Distinction
LO4 Propose solutions that meet the requirements for safe demolition and disposal of materials for a large-scale construction project		
P7 Explain the different methods for large-scale construction demolition and their suitability for different types of project. **P8** Define a strategy for demolition of a large-scale construction project, including the transport and disposal of materials.	**M4** Analyse the importance of construction information in the process of preparing for and undertaking demolition works.	**D3** Justify the need for re-use, reclamation or recycling during demolition to support sustainability through a building lifecycle.

Recommended Resources

Print resources

ADDIS, B. (2012*), Building with Reclaimed Components and Materials*, Routledge

BROOKES, A., GRECH, C. (1994), *Connections*, Watson-Guptill Publications

BROOKES, A., GRECH, C. (1996), *The Building Envelope and Connections*, Architectual Press

BRYAN, T. (2015), *Construction Technology*, John Wiley & Sons

CHING, F. (2011), *Building Construction Illustrated*, John Wiley & Sons

COOKE, R. (2007), *Building in the 21st Century*, Wiley-Blackwell

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), *Chudley and Greeno's Building Construction Handbook,* Butterworth-Heinemann

EMMITT, S. (2018), *Barry's Advanced Construction of Buildings*, John Wiley & Sons

SOMAYAJI, S. (2001), *Civil Engineering Materials*, Pearson College Division

Web resources

https://www.bregroup.com	**BRE** (General Reference)
https://srdi.hk	**Chartered Association of Building Engineers** (Professional Body)
https://srdi.hk	**Chartered Institute of Architectural Technologists** (Professional Body)
https://www.ciob.org	**Chartered Institute of Building** (Professional Body)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)
https://srdi.hk	**The Concrete Centre** (General Reference)
https://srdi.hk	**The Institution of Structural Engineers** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 31: Advanced Structural Design
- Unit 47: Advanced Building Information Modelling.

Unit 34: Further Mathematics for Construction

Level: 5

Credits: 15

Ofqual Code: M/618/8110

Introduction

The understanding of more advanced mathematics is important in the civil engineering and building services engineering industries. Students will 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 the unit are: number theory, complex numbers, matrix theory, linear equations, numerical integration, numerical differentiation, and graphical representations of curves for estimation in an engineering context. 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:

LO1 Apply instances of number theory in practical construction situations

LO2 Solve systems of linear equations relevant to construction applications using matrix methods

LO3 Approximate solutions of contextualised examples with graphical and numerical methods

LO4 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 (e.g., denary, binary, octal, duodecimal, hexadecimal) and converting between bases

Types of numbers (e.g., 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 2×2 matrix

Using the inverse of a square matrix to solve linear equations

Gaussian elimination to solve systems of linear equations (up to 3×3)

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, 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 (e.g., electric circuit theory, load frequency control, harmonic vibrations of beams and engine governors)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Apply instances of number theory in practical construction situations		
P1 Apply addition and multiplication methods to numbers that are expressed in different base systems. **P2** Solve construction problems using complex number theory. **P3** Perform arithmetic operations using the polar and exponential form of complex numbers.	**M1** Deduce solutions of problems using de Moivre's Theorem.	**D1** Test the correctness of a trigonometric identity using de Moivre's Theorem.
LO2 Solve systems of linear equations relevant to construction applications using matrix methods		
P4 Ascertain the determinant of a 3 × 3 matrix. **P5** Solve a system of three linear equations using Gaussian elimination.	**M2** Determine solutions to a set of linear equations using the inverse matrix method.	**D2** Validate all analytical matrix solutions using appropriate computer software.
LO3 Approximate solutions of contextualised examples with graphical and numerical methods		
P6 Estimate solutions of sketched functions using a graphical estimation method. **P7** Identify the roots of an equation using two different iterative techniques. **P8** Determine the numerical integral of construction functions using two different methods.	**M3** Evaluate construction problems to formulate mathematical models using numerical and graphical methods.	**D3** Critique the use of numerical estimation methods, commenting on their applicability and the accuracy of the methods.

Pass	Merit	Distinction
LO4 Review models of construction systems using ordinary differential equations		**D4** Evaluate first- and second-order differential equations when generating the solutions to construction problems.
P9 Determine first-order differential equations using analytical methods. **P10** Determine second-order homogeneous and non-homogenous differential equations using analytical methods. **P11** Calculate solutions to linear ordinary differential equations using Laplace transforms.	**M4** Analyse how first-order differential equations are used to solve structural or environmental problems.	

Recommended Resources

Print resources

BIRD, J. (2017), *Higher Engineering Mathematics*, Routledge

SINGH, K. (2011), *Engineering Mathematics Through Applications*, Macmillan International Higher Education

STROUD, K., BOOTH, D. (2001), *Engineering Mathematics*, Industrial Press Inc.

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, Ventilation and Air Conditioning
- Unit 10: Measurement & Estimating
- Unit 16: Principles of Public Health Engineering
- Unit 21: Geotechnics & Soil Mechanics
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 41: Highway Engineering
- Unit 43: Advanced Surveying & Measurement
- Unit 49: Advanced Electrical Design & Installation.

Unit 35: Sustainable Methods of Construction

Level: 5

Credits: 15

Ofqual Code: T/618/8111

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 CO_2 emissions and is under increasing pressure, and legislation, to improve its processes and practices.

However, the industry faces further 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 that are fit for purpose, considered government policy implications and health and 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:

LO1 Examine how the construction industry impacts on the environment and how changes in the industry can create broader social and economic benefits

LO2 Explore sustainable construction methods that are fit for purpose in a given context

LO3 Discuss the potential benefits and challenges associated with different forms of sustainable construction

LO4 Present a design proposal, utilising a selected sustainable construction method, and explain how it is 'fit for purpose' in the given context.

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 impact

Global warming

Carbon emissions

Construction statistics (e.g., carbon emissions, energy consumption)

Social and economic factors

Industry contribution to national economies

Government targets (e.g., carbon reduction, energy use)

International agreements/accords (e.g., Paris Agreement, Kyoto Protocol)

Housing demand (e.g., affordable homes, housing market)

Urbanisation (greenfield use, brownfield sites)

Sustainability protocols

Passivhaus/Passive House

BREEAM

LEED

SAP (Standard Assessment Procecure)

Code for Sustainable Homes

LO2 **Explore sustainable construction methods that are fit for purpose in a given context**

Timber systems

Timber frame

Cross-laminated timber

Off-site manufacture

Prefabrication

Panelised systems (e.g., structural insulated panels (SIP), ceramic composite panels)

Volumetric systems

Modularisation/componentisation

Other

Traditional

Rammed earth

Cob/adobe

Sandbag

Straw bale

Other

LO3 Discuss the potential benefits and challenges associated with different forms of sustainable construction

Potential benefits

Improved working conditions (e.g., off-site construction in controlled environment)

Reduced environmental impact (e.g., reduced waste, lower emissions, better component/building performance, better use of renewables)

Faster construction (e.g., off-site construction has less impact from adverse weather, automated systems can operate longer hours, modular/panelised systems require less time on site)

More reliable/higher quality (e.g., off-site construction works at lower tolerances, less human error, technology integration throughout process)

Challenges

Market acceptance (e.g., public perception of 'new', untested at larger-scale buildings)

Industry investment (e.g., cost of off-site facilities, retraining of staff, closing 'skills gaps')

Legislation and regulation (e.g., some building regulations do not support alternative methods, complex health and safety regulations (off-site+on-site))

LO4 **Present a design proposal, utilising a selected sustainable construction method and explain how it is ‘fit for purpose’ in the given context**

Client requirements

Building use

Budget

Environmental targets

Project type

Residential (e.g., multi-occupancy, apartments, flats)

Commercial (e.g., office buildings, shopping centres)

Cultural (e.g., museums, theatres, stadiums, exhibition halls)

Industrial (e.g., factories, warehouses, garages)

Medical/scientific (e.g., hospitals, clinics, laboratories)

Project scale

Single-storey vs multi-storey

Long-span

High traffic (e.g., large number of occupants/users)

Design proposal

Strategy

Feasibility (e.g., construction costs, operational costs)

Drawings/models (e.g., plans, sections, elevations, details)

Permissions (e.g., planning permissions, building regulations, health and safety)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine how the construction industry impacts on the environment, and how changes in the industry can create broader social and economic benefits		
P1 Explore how the construction industry has an impact on the environment. **P2** Examine how social and economic factors have an effect on the construction industry.	**M1** Assess how effective government targets and national statistics have been on environmental protection.	**D1** Evaluate the potential for environmental protection through the specification of sustainable construction methods.
LO2 Explore sustainable construction methods that are fit for purpose in a given context		
P3 Examine the development of sustainable construction methods using examples. **P4** Explore sustainable construction methods and their application to different building types.	**M2** Compare sustainable construction methods in terms of effectiveness, cost and performance.	

Pass	Merit	Distinction
LO3 Discuss the potential benefits and challenges associated with different forms of sustainable construction		**D2** Justify the use of a chosen sustainable construction method in meeting a range of challenges.
P5 Explore the potential benefits of sustainable methods of construction. **P6** Explain the challenges associated with sustainable methods of construction.	**M3** Illustrate the ways in which different sustainable methods of construction may address challenges.	
LO4 Present a design proposal, utilising a selected sustainable construction method, and explain how it is 'fit for purpose' in the given context		
P7 Produce design and technical information to support a proposed sustainable method of construction for a given building type. **P8** Present a design proposal that utilises sustainable methods of construction.	**M4** Evaluate the integration of health and safety, building regulations and statutory requirements in a sustainable construction proposal.	

Recommended Resources

Print resources

COTTERELL, J., DADEBY, A. (2012), *The Passivhaus Handbook: A practical guide to constructing and retrofitting buildings for ultra-low energy performance*, Green Books

ELIZABETH, L., ADAMS, C. (2005), *Alternative Construction*, Wiley

GARBER, R. (2014), *BIM Design*, John Wiley & Sons

HICKEY, T. (2014), *Construction Technology: Designing Sustainable Homes*, Gill Education

JONES, B. (2015), *Building with Straw Bales*, Green Books

LAWSON, M., OGDEN, R., GOODIER, C. (2014), *Design in Modular Construction*, CRC Press

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 15: Principles of Alternative Energy
- Unit 23: Construction Economics & Sustainability
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 47: Advanced Building Information Modelling.

Unit 36: Value Engineering & Cost Control

Level: 5

Credits: 15

Ofqual Code: L/618/8132

Introduction

A client's project needs to meet three essential outcomes. The first is value, the second time and the last quality. Value is the primary one that includes costs associated with the design, installation, operating and maintaining of the client's project. A client in today's economy expects a project to deliver 'value for money' against the functional use of the completed project. If alternatives can be explored that deliver the same outcomes for less expenditure, then substantial cost savings can be made. Value engineering, value planning and value analysis are all terms that are associated with such processes in ensuring that a client receives the best possible outcome for their project investment.

Savings should not be seen as short-term goals but as longer term – over the life of a building from cradle to grave. This is termed 'lifecycle costing' and explores the costs associated with the whole life of a building. It may be prudent to spend more initially, to gain long-term savings over the life of a building. The quantity surveyor or cost consultant can, therefore, advise a client on initial expenditure and where their investment in the project gives the greatest engineered value in the long run. This is often the role of the professional quantity surveyor, engaged as the client's consultant.

In this unit, students will explore the application of value engineering principles to scenarios or case studies in order to develop an understanding of how they are applied in a construction context. Students will also explore the various methods used to control costs. Through an understanding of cost control and value engineering, students will develop their knowledge and skills in order to manage and reconcile project costs.

Learning Outcomes

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

LO1 Explain the principles of value engineering in construction projects

LO2 Apply value engineering principles to a construction project

LO3 Describe the principles of cost control in construction projects

LO4 Demonstrate the application cost analysis for a given construction project.

Essential Content

LO1 **Explain the principles of value engineering in construction projects**

Value planning

Information gathering stages

Idea planning

Definitions, clarifications, agreement, approval planning

Initial planning stages design, feasibility

Strategic briefing planning

Revisions of design into final design/specification

Project brief, integration of value concepts into the technical design

Production of final specification/drawings

Resource analysis

Value engineering

Identification of costs associated with whole project lifecycle

Identification of unnecessary costs and functions

Assessment of the availability of resources

Analysis of building methods

Site limitations

Environmental impact analysis

Sustainability analysis

Identification of best value alternatives

Development of alternative solutions

Selection of alternatives in meeting strategic brief

Full costing of alternatives

Approval and inclusion of alternatives

Allocation of costs to alternative solutions

Value analysis

Breakdown of project into packages

Earned value analysis of packages

Actual outputs

Planned outputs

Measurement of actual against planned resources

Charts and plotting graphs

Benchmarking

LO2 **Apply value engineering principles to a construction project**

Project information

Client's detailed brief

Working drawings

Specifications

Analysis of project

Functionality

Sustainability

Environmental impact

Budget cost breakdown

Alternative specifications versus functionality

Alternative proposals

Material alternatives

Construction process alternatives (e.g., methods, time)

Procurement alternatives

Costing of alternative proposals

Lifecycle costing evaluations (e.g., construction costs, energy costs, environmental impact, operational costs)

Acceptance of proposals from client

Calculation of re-valued costs/savings made

Revision of budget

LO3 **Describe the principles of cost control in construction projects**

Client's perspective

Tendering procedures to obtain a contractor

Tender adjudication

Tender figures analysed against budget

Cost-reduction measures

Revision to budget

Award of contract

Variations to contract

Contract cost monitoring and reporting

Final account

Main contractor perspective

Control of materials (e.g., analysis of estimated costs, purchase against estimated costs, reduction in wastage, alternative specifications, offsite prefabrication)

Control of labour (e.g., use of labour-only subcontractors on agreed output rates, domestic subcontract packages, directly employed labour, calculation of a project's total labour hours)

Control of plant (e.g., plant costs, total plant hours, transport costs, mobilisation costs)

Control of subcontractors (e.g., nominated and named, domestic packages, values within estimate, actual nett package values)

Cost value reconciliation (e.g., main contractor's costs vs valuations, time intervals conducted, calculation of revenue/value, calculation of total expenditure, adjustments to costs (materials delivered not invoiced, time lag on invoices, delays, losses))

Reconciliation of costs vs revenue

Comparison against projected project margin

Charts and management graphic records

Reporting to company directors

Action planning

Cost control relationships

Managing expectations

Avoiding and managing conflicting aims

Working to ensure quality and safety

LO4 **Demonstrate the application cost analysis for a given construction project**

Project definition

Project type

Project scale

Project estimate

Predicted expenditure versus revenue

Costs to date

Revenue to date

Variations to date

Architects' instruction to date

Cost adjustment data

Re-plotting of margin analysis chart

Cost benefit analysis

Analysis of costs and calculation against time interval

Analysis of revenue to date

Calculation of profit margin or loss

Cost adjustment for future unrecoverable expenditure

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the principles of value engineering in construction projects		**D1** Evaluate the benefits of value analysis and value engineering for a given project.
P1 Describe the concepts of value planning and value engineering. **P2** Discuss the ways in which value engineering seeks to balance quality, cost and sustainability.	**M1** Analyse value planning alongside value engineering.	
LO2 Apply value engineering principles to a construction project		
P3 Produce a value analysis of a project. **P4** Describe alternative value proposals for a project.	**M2** Calculate the lifecycle costs of alternative value engineered proposals.	
LO3 Describe the principles of cost control in construction projects		**D2** Justify revised proposals in achieving the project margin.
P5 Describe cost control from the client and contractor perspective. **P6** Discuss the potential areas of conflict in cost control.	**M3** Analyse the potential areas of difference in cost control between client and contractor.	
LO4 Demonstrate the application cost analysis for a given construction project		
P7 Describe the concept of cost benefit analysis. **P8** Produce a cost value reconciliation for a specific construction project.	**M4** Devise alternative proposals to pull a contract back onto target margins.	

Recommended Resources

Print resources

KELLY, J., MALE, S. (2003), *Value Management in Design and Construction*, Routledge

KELLY, J., MALE, S., GRAHAM, D. (2014), *Value Management of Construction Projects*, John Wiley & Sons

POTTS, K., ANKRAH, N. (2014), *Construction Cost Management*, Routledge

TOWEY, D. (2013), *Cost Management of Construction Projects*, John Wiley & Sons

Web resources

https://www.designingbuildings.co.uk	**Designing Buildings Wiki – Cost Control in Building Design and Construction** (Article)
https://www.designingbuildings.co.u	**Designing Buildings Wiki – Value Engineering** (Article)
https://www.rics.org	**Royal Institution of Chartered Surveyors** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 23: Construction Economics & Sustainability
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 29: Contracts & Management
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 54: Advanced Quantity Surveying Practice.

Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation

Level: 5

Credits: 15

Ofqual Code: A/618/8112

Introduction

Modern high-rise and multi-zone buildings have complex requirements for heating, cooling and ventilation. Their scale, number of occupants and need for better performance and efficiency, mean that the design and installation of systems for heating, cooling and ventilation are critical.

This unit supports students to build an understanding of the broad application of technologies and design techniques used to satisfy the requirements in 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:

LO1 Discuss the HVAC systems and technologies that serve large commercial or complex/multi-zone buildings

LO2 Analyse the design requirements for large commercial or complex/multi-zone buildings when specifying heating, ventilation or air conditioning components and systems

LO3 Explain how sustainability can be integrated into the design, installation and operation of large-scale and complex HVAC systems

LO4 Present a proposal for an advanced HVAC system for a complex/multi-zone building.

Essential Content

LO1 **Discuss the 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

Client requirements

Project type

Performance requirements

Health and safety requirements

LO2 **Analyse the design requirements for large commercial or complex/multi-zone buildings when specifying heating, ventilation or air conditioning components and systems**

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

Legislation and regulation

Building regulations

Public health regulations

Professional codes of practice

Health and safety legislation

Site safety requirements

Energy consumption regulations

Emissions regulations

LO3 **Explain how sustainability can be integrated into the design, installation and operation of large-scale and complex HVAC systems**

General

Regulations and compliance requirements (e.g., building regulations, public health regulations)

National and international sustainability targets (e.g., climate accords, international agreements, national targets)

Assessment and certifications (e.g., BREEAM, LEED, Energy Performance Certificates (EPC), Display Energy Certificates)

Credit systems (e.g., Renewable Energy Credits (REC), Renewables Obligation Certificates (ROC), Renewable

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

Ventilation

Plant sizing for large-scale projects

Air volumes

Operation and control of plant

Cooling

Plant sizing for large-scale projects

Water-based cooling

Limitations in refrigerant pipework distances

Control and turndown of plant

Construction information

Plant equipment selection and specification (e.g., heat generation, cooling system, ventilation fans, calculations for sizing)

Component selection and specification (e.g., heat emitters, terminal devices, air-handling, ductwork, calculations for sizing)

Drawings (plant room layout, ductwork schematics, heat emitter locations, ventilation intake and terminal locations)

Commissioning

Testing of water supply and quality (e.g., hot and cold water)

Heating system (e.g., heat production, heat distribution, heat recovery, temperature control)

Cooling system (e.g., air conditioning components, temperature control)

Ventilation (e.g., air changes, supply and return air, ductwork, acoustics)

Waste systems

HVAC system controls

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the HVAC systems and technologies that serve large commercial or complex/multi-zone buildings		**D1** Propose changes to an existing HVAC installation in order to better meet current legislative and regulatory requirements.
P1 Discuss the HVAC systems commonly used for commercial buildings. **P2** Review plant items and distribution methods for advanced HVAC systems.	**M1** Illustrate the HVAC operation of a given complex/multi-zone building.	
LO2 Analyse the design requirements for large commercial or complex/multi-zone buildings when specifying heating, ventilation or air conditioning components and systems		
P3 Discuss the current legislation and codes of practice that influence the design and selection of HVAC systems. **P4** Review an existing HVAC system, for a given complex/multi-zone building, with regard to the way it meets current legislation and regulation requirements.	**M2** Assess the impact of regulation and legislation on the selection of HVAC components and systems.	

Pass	Merit	Distinction
LO3 Explain how sustainability can be integrated into the design, installation and operation of large-scale and complex HVAC systems		
P5 Discuss the economic and legislative drivers for sustainability in HVAC systems. **P6** Assess the effectiveness of different approaches to sustainability in HVAC system design, installation and operation.	**M3** Demonstrate how different sustainable HVAC strategies result in lower power consumption and/or lower emissions.	**D2** Justify the specification and design of an HVAC system for a given large-scale building in how it provides a sustainable solution to the heating, cooling and ventilation needs.
LO4 Present a proposal for an advanced HVAC system for a complex/multi-zone building		
P7 Specify the plant, distribution system and components, based on calculation, for the HVAC system of a given large-scale building. **P8** Produce the construction information required to support the installation and commissioning of an HVAC system in a given large-scale building.	**M4** Compare alternative HVAC systems designs to determine the optimal solution for a given large-scale building.	

Recommended Resources

Print resources

AL-SHEMMERI, T., PACKER, N. (2021), *Building Services Engineering*, John Wiley & Sons

BUTCHER, K. (2005), *Heating, Ventilating, Air Conditioning and Refrigeration*, Chartered Institution of Building Services Engineers

CHADDERTON, D. (2014), *Air Conditioning*, Routledge

CHADDERTON, D. (2004), *Building Services Engineering*, Routledge

GREENO, R. (2014), *Building Services, Technology and Design*, Routledge

HALL, F., GREENO, R. (2017), *Building Services Handbook*, Taylor & Francis

PORTMAN, J. (2016), *Building Services Engineering*, John Wiley & Sons

WATKINS, D. (2011), *Heating Services in Buildings*, John Wiley & Sons

Links

This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 13: Building Information Modelling
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 34: Further Mathematics for Construction
- Unit 48: Thermofluids & Acoustics
- Unit 49: Advanced Electrical Design & Installation
- Unit 50: Building Management Systems.

Unit 38: Advanced Quantities for Complex Building Projects

Level: 5

Credits: 15

Ofqual Code: F/618/8113

Introduction

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. Students will also have the fundamental knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

LO1 Apply measurement techniques to a range of complex situations

LO2 Produce measured quantities for a range of elements and components on large-scale projects

LO3 Develop relevant contract preamble and preliminary items for given situations

LO4 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 (e.g., reinforcement, door, window, ironmongery, finishes)

Measurement of variations on a project

Production of sub-contract

Production of supply packages

Production of final accounts

Specialist works

Maintenance works

Refurbishment works

LO2 Produce measured quantities for a range of elements and components on large-scale projects

Substructures

Foundations (e.g., footings, pilings, basements, underpinning)

Earthworks (e.g., site stabilisation, retaining walls, culverts)

Superstructures

Concrete and steel framed buildings (e.g., in situ, pre-cast and pre-stressed concrete structures, brick and masonry structures)

Cladding and curtain walling (e.g., secondary structure, cladding materials, curtain wall systems)

Masonry buildings (e.g., brick, concrete block)

Roofs and roofing (flat roofs, pitched roofs, green roofs, flashing, cladding, parapets)

Windows and doors (e.g., internal doors, external doors, fire-ratings, casement windows, double-hung windows)

Finishes (e.g., internal, external, flooring, wall treatments, flame spread ratings)

Stairs and lifts (e.g., internal stairs, escape stairs, passenger lifts, goods lifts, firefighter lifts)

Building engineering services

Plumbing

Heating

Ventilation

Air conditioning

Electrical installations

Above and below ground disposal systems

Building Information Modelling (BIM) for measuring

Opportunities and challenges

LO3 **Develop relevant contract preamble and preliminary items for given situations**

Production of preamble clauses

Forms of contract

Contract conditions

Parties to the contract

Definitions

Units

Method of measurement

Procurement process

Extent of works

Tender process

Tender documents

Production of preliminary clauses

Preconstruction activities

Statutory approvals

Quality procedures

Insurance

Performance bonds and warranties

Possession

Reporting procedures by main contractor

Pre-construction health and safety plan

Site waste management plan (SWMP)

Contractors' items (e.g., 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**

Bills of quantities

Method of measurement (e.g., NRM, SMM7 (Legacy), CESMM, ICMS, IPMS)

Categorising Works (e.g., Common Arrangement of Work Sections (CAWS), Uniclass, Omniclass)

Elemental or Works Package preparation

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Apply measurement techniques to a range of complex situations		
P1 Produce a schedule for an element. **P2** Produce a sub-contract package.	**M1** Differentiate between a sub-contract and a supply package.	**D1** Critically evaluate manual vs digital taking-off techniques.
LO2 Produce measured quantities for a range of elements and components on large-scale projects		
P3 Take-off quantities for a complex substructure element. **P4** Take-off quantities for a complex superstructure element.	**M2** Take-off quantities using digital methodology.	
LO3 Develop relevant contract preamble and preliminary items for given situations		
P5 Identify an appropriate form of contract for a given construction project. **P6** Develop contract preamble and preliminary clauses for a complex project.	**M3** Justify the inclusion of preliminary clauses for a project.	**D2** Critically analyse the preamble clauses of a contract in relation to stakeholders needs in a given project.
LO4 Create measured bills of quantities and schedules using both manual and computer techniques		
P7 Produce a bill of quantities for a work section using manual techniques. **P8** Produce a bill of quantities for a work section using digital techniques.	**M4** Compare the accuracy of manual vs digital taking-off techniques.	**D3** Justify the use of digital or manual taking-off for specific work sections of a bill of quantities.

Recommended Resources

Print resources

ASHWORTH, A., HOGG, K., HIGGS, C. (2013), *Willis's Practice and Procedure for the Quantity Surveyor*, John Wiley & Sons

CARTLIDGE, D. (2019), *Estimator's Pocket Book Second Edition*, Routledge

OSTROWSKI, S. (2013), *Estimating and Cost Planning Using the New Rules of Measurement*, John Wiley & Sons

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

Web resources

https://www.designingbuildings.co.uk	**Designing Buildings Wiki** (General Reference)
https://www.rics.org	**Royal Institution of Chartered Surveyors** (Professional Body)

Links

This unit links to the following related units:

- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling.

Unit 39: Personal Professional Development

Level: 5

Credits: 15

Ofqual Code: J/618/8114

Introduction

As a professional, learning is a continuous and lifelong process. In the construction industry there are constant changes in technology, materials, processes, legislation and practice. In order to stay up to date, it is necessary to recognise the potential of both structured, classroom-based learning and the learning gained through professional activities ‘on the job’.

This unit provides a framework in which students have the opportunity to reflect on and contextualise the learning they gain from working in the industry. In coordination with tutors and their employers, 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 on their own learning.

Learning Outcomes

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

LO1 Assess personal learning needs and opportunities in the context of employment

LO2 Plan and manage own personal learning journey, through consultation with employer and/or tutor/instructor

LO3 Record personal progress and the feedback of others; responding as appropriate to own future development

LO4 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 in 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

Industry needs

Supporting equality and diversity

Ensuring quality in the built environment

Improving health and safety

LO2 Plan and manage own personal learning journey, through consultation with employer and/or tutor/instructor

Setting goals

SMART goals (specific, measurable, attainable, relevant, time-bound)

Learning goals vs employment goals

Learning plan

Goals

Actions

Resources

Professional recognition

Professional bodies

CPD requirements of professional recognition

Professional recognition levels (e.g., technician, registered, chartered, fellow)

Professionalism (e.g., codes of conduct, codes of practice)

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

Reflection vs description

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: 'Four Lenses'

Evaluating success

Measurement

Learning from failure

Future planning

CPD and lifelong learning Personal Development Planning (PDP) Career goals, personal goals, company goals

Developing management skills (managing work, managing people, dealing with conflict)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Assess personal learning needs and opportunities in the context of employment		
P1 Review prior learning and employer operations to identify potential areas for development. **P2** Undertake a skills audit to define areas of personal development/training needs.	**M1** Analyse personal training/development needs in relation to industry needs, including equality and diversity, health and safety and ensuring quality.	**D1** Justify personal development plans in relation to employer needs, identifying resource requirements and time commitments of self and others.
LO2 Plan and manage own personal learning journey, through consultation with employer and/or tutor/instructor		
P3 Develop a personal development plan that reflects both individual and employer needs. **P4** Present a personal development plan to an employer and/or tutor.	**M2** Evaluate the integration of professional recognition within personal development planning.	
LO3 Record personal progress and the feedback of others; responding as appropriate to own future development		**D2** Critically evaluate own learning and development, to communicate examples of good practice and improvement for the future.
P5 Manage own personal development through the course of the work-based learning experience. **P6** Review own progress and development periodically.	**M3** Reflect on instances of success and failure in meeting own and company goals.	
LO4 Evaluate own learning, based on personal experience and comments from others, in order to plan for the future		
P7 Assess own learning and development through reflection and 360-degree feedback. **P8** Prepare a plan for future development in relation to career goals.	**M4** Evaluate career goals in relation to future learning and professional development needs.	

Recommended Resources

Print resources

BOLTON, G., DELDERFIELD, R. (2018), *Reflective Practice*, SAGE

COTTRELL, S. (2015), *Skills for Success*, Macmillan International Higher Education

HELYER, R. (2015), *The Work-Based Learning Student Handbook*, Macmillan International Higher Education

MOON, J. (2018), *Learning Journals*, Routledge

MEGGINSON, D., WHITAKER, V. (2017), *Continuing Professional Development*, Kogan Page Publishers

PRITCHARD, A. (2017), *Ways of Learning*, Routledge

RAELIN, J. (2008), *Work-Based Learning*, John Wiley & Sons

SCHÖN, D. (1991), *The Reflective Practitioner*, Routledge

TARRANT, P. (2013), *Reflective Practice and Professional Development*, SAGE Publications Limited

THOMPSON, S. (2018), *The Critically Reflective Practitioner*, Macmillan International Higher Education

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 12: Tender & Procurement
- Unit 20: Site Supervision & Operations
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 44: Maintenance & Operations.

Unit 40: Surveying for Conservation, Renovation & Refurbishment

Level: 5

Credits: 15

Ofqual Code: L/618/8115

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 introduces students to the process, techniques and underpinning knowledge required to undertake a survey of a building. The focus is 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. Students 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 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 give students 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 will also benefit from the knowledge of historic methods of construction.

Learning Outcomes

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

LO1 Examine an existing building to determine its character and the need for renovation or refurbishment

LO2 Analyse a given building to determine the range of methods/systems used in its construction

LO3 Assess mechanisms of failure and deterioration in buildings

LO4 Present a building survey report in support of a proposed renovation or refurbishment scheme.

Essential Content

LO1 **Examine an existing building to determine its character and the need for renovation or refurbishment**

Residential property

Private residential

Multi-occupancy (e.g., flats, apartments)

Commercial buildings

Retail (e.g., shop, restaurant, shopping mall)

Office (e.g., small office building, high-rise office building)

Multi-use (e.g., office, retail, residential)

Cultural buildings

Museums/galleries

Performance halls

Industrial buildings

Factories

Warehouses

Medical buildings

Hospitals

Clinics

Laboratories

Interiors

Residential interiors

Commercial interiors

Medical interiors

Renovation vs refurbishment

Renovation (e.g., substantive changes, structural modifications, extension)

Refurbishment (e.g., minimal changes, making good, upgrading, includes preservation, conservation and restoration)

Issues for historic buildings

Architectural periods (e.g., Victorian, Georgian, Edwardian, Modernist)

Preservation (e.g., protection from further deterioration, maintaining as much as possible, minimal changes, safety and history driven)

Conservation (e.g., unaltered condition, reversible changes, maintain original materials, history driven)

Restoration (e.g., return to original, use of original materials and processes, aesthetically driven)

LO2 **Analyse a given building to determine the range of methods/systems used in its construction**

Framed construction

Timber framing (e.g., machined timber, green timber)

Iron and steel framing

Framed construction infill (e.g., wattle and daub, brick, stone, concrete, timber)

Timber cavity walls

Insulation in framed construction

Masonry construction

Dry stone

Dressed stone

Concrete block

Brick

Mud brick (e.g., adobe)

Masonry cavity walls

Insulation in masonry construction

Curtain walling

Secondary structure

Curtain walling material (e.g., glass, composite panels, stone panels)

Other construction methods

Rammed earth

Cobb

Roof construction

Roof form (e.g., flat, pitched, mansard, dome, conical)

Roof framing (e.g., timber, steel, truss, masonry)

Roof covering (e.g., slate, clay tiles, thatch, green roof, battens, felt, asphalt, bitumen)

LO3 **Assess mechanisms of failure and deterioration in 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 (e.g., 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 (e.g., expansion, shrinkage)

Human impact (e.g., vandalism, arson, accidental damage)

LO4 **Present a building survey report in support of a proposed renovation or refurbishment scheme**

Undertaking a building survey

Health and 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

Level of work

Renovation

Refurbishment

Conservation

Presenting information

Survey report styles

Formats

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine an existing building to determine its character and the need for renovation or refurbishment		**D1** Critically analyse the relationship between architectural style, building type and materials in a given building.
P1 Discuss different building types and their characteristics. **P2** Discuss the difference between conservation, preservation and restoration in historic buildings.	**M1** Evaluate the development of architectural styles in relation to cultural context.	
LO2 Analyse a given building to determine the range of methods/systems used in its construction		
P3 Explore the methods of construction in a given building. **P4** Analyse the way that roof structure and wall structure work together for a given building.	**M2** Evaluate the relationship between material and construction method.	

Pass	Merit	Distinction
LO3 Assess mechanisms of failure and deterioration in buildings		**D2** Justify a proposal for conservation/renovation or restoration of a given building, with reference to surveyed defects.
P5 Differentiate between mechanisms of failure and deterioration in the fabric of a building. **P6** Analyse building defects and explain the mechanism of their failure.	**M3** Evaluate the condition and defects, and determine reasons for failure in a given building.	
LO4 Present a building survey report in support of a proposed renovation or refurbishment scheme		
P7 Plan and undertake a survey of a given building in relation to a proposed renovation or refurbishment scheme. **P8** Produce a professional building survey report in support of a renovation or refurbishment scheme.	**M4** Record the construction methods and condition of a given building.	

Recommended Resources

Print resources

BECKMANN, P., BOWLES, R. (2012), *Structural Aspects of Building Conservation*, Routledge

FORSYTH, M. (2014), *Structures and Construction in Historic Building Conservation*, John Wiley & Sons

GLOVER, P. (2009), *Building Surveys*, Elsevier

HOXLEY, M. (2019), *Building Condition Surveys*, Routledge

LOURENÇO, P., GROUP, T., GAETANI, A. (2021), *Historic Construction and Conservation*, Routledge

WATT, D. (2015), *Surveying Historic Buildings*, Routledge

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 19: Principles of Structural Design
- Unit 23: Construction Economics & Sustainability
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling.

Unit 41: Highway Engineering

Level: 5

Credits: 15

Ofqual Code: D/618/8118

Introduction

The quick and flexible means of transport afforded to us by motor vehicles has transformed modern life. This ease of mobility is made possible 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 busways', however we 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 and explain civil engineering aspects, including pavement types. They will also be able to appraise improvements to the existing road infrastructure.

Learning Outcomes

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

LO1 Evaluate how a new highway route is identified, planned and designed

LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways

LO3 Specify a form of pavement construction for a given highway provision

LO4 Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning.

Essential Content

LO1 Evaluate how a new highway route is identified, planned and designed

Highway identification and planning

Assessment of traffic volumes

Variables affecting traffic volumes

Land acquisition procedures (including alignment design)

Public consultation (e.g., environmental impact assessment, public meetings, statutory requirements, health and safety)

Funding arrangements (e.g., proposed tolls, taxes)

Highway design

Horizontal and vertical alignment

Environmental impact assessment requirements

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)

Highway users and user needs (e.g., general public, heavy goods vehicles, emergency use, access and maintenance)

LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways

Earthwork operations methods

Cut and fill balancing

Ground stabilisation techniques (e.g., lime injection, geogrid, retaining walls, specialist plant required)

Forming of embankments (retaining walls, angle of repose, stabilisation)

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 (e.g., cut and cover, pipe jacking, boring)

Boring machinery

Soils conditions

Proposed destination for surplus material

Maintenance arrangements

Materials used for tunnel linings

LO3 **Specify a form of pavement construction for a given highway provision**

Flexible pavement construction

Materials (e.g., dense bitumen macadam, high-density macadam, pervious macadam, mastic asphalt, hot rolled asphalt)

Properties and uses of aggregates

Common construction methods

Environmental performance

Skid resistance

Deterioration

Sub-base materials

Rigid pavement construction

Concrete (e.g., mix details, reinforcement, joint details)

Use of pavement trains

Environmental performance

Skid resistance

Deterioration

Sub-base materials

LO4 **Present a proposal for 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

Traffic management systems

Technology to improve public transport systems

Safety measures

Maintenance planning and techniques

Common degradation processes for highway structures

Essential or routine repair to concrete supporting infrastructure

Renewing worn out pavement surfaces

Repair schedule and asset management (e.g., surveying road conditions, digital asset management)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate how a new highway route is identified, planned and designed		**D1** Critically analyse the properties of materials required for structural application in bridges and tunnels.
P1 Discuss how the route of a new section of highway is identified and planned. **P2** Explain the role of public consultation in higher planning.	**M1** Analyse the relationship between highway use and traffic volumes.	
LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways		
P3 Analyse the earthwork operations required for construction of a new highway in a developed area with difficult terrain. **P4** Review the earthwork processes involved in the formation of tunnels and bridges for a new highway.	**M2** Evaluate the need for ground stabilisation associated with bridge and tunnel construction for a new highway.	
LO3 Specify a form of pavement construction for a given highway provision		
P5 Assess the requirements of a given highway construction proposal. **P6** Specify the pavement type for a new highway construction.	**M3** Compare flexible and rigid pavement construction for a new highway.	**D2** Justify the specification of a pavement type for a new highway, based on performance characteristics.
LO4 Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning		
P7 Present improvements to a given existing and new highway provision. **P8** Discuss common highway faults and effective maintenance regimes as preventative measures for a given project.	**M4** Assess the techniques and methods that may improve the effectiveness and conditions of a given highway project.	**D3** Critically evaluate proposed improvements to a highway infrastructure scheme to identify alternative approaches to improve performance and reliability.

Recommended Resources

Print resources

HUGHES, D., O'FLAHERTY, C. (2015), *Highways*, ICE Publishing

MANNERING, F., WASHBURN, S. (2020), *Principles of Highway Engineering and Traffic Analysis*, John Wiley & Sons

ROGERS, M., ENRIGHT, B. (2016), *Highway Engineering*, John Wiley & Sons

SOMAYAJI, S. (2001), *Civil Engineering Materials*, Pearson College Division

WATSON, J. (1994), *Highway Construction and Maintenance*, Halsted Press

Web resources

https://ciht.org.uk	**Chartered Institution of Highways & Transportation** (Professional Body)
https://nationalhighways.co.uk	**Highways England** (General Reference)
https://theihe.org	**The Institute of Highways Engineers** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 36: Value Engineering & Cost Control
- Unit 42: Hydraulics
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling.

Unit 42: Hydraulics

Level: 5

Credits: 15

Ofqual Code: H/618/8119

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.

In 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:

LO1 Calculate forces related to fluids at rest and in motion

LO2 Develop practical solutions for the distribution of fluids within correctly sized pipes

LO3 Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems

LO4 Calculate the hydrostatic pressure exerted on substructures for a given context.

Essential Content

LO1 Calculate forces related to fluids at rest and in motion

Flow calculation

Bernoulli's equation

Hydraulic radius

Velocity distribution

Reynolds number

Darcy-Weisback equation

Manning's equation

Energy

The energy principle

The energy equation

Hydraulic grade

Energy grade

Energy loss/gain

Friction losses

LO2 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

LO3 Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems

Fluid properties

Density

Viscosity

Fluid behaviour

Viscous flow

Laminar flow

Turbulence

Boundary layer

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
LO1 Calculate forces related to fluids at rest and in motion		**D1** Assess pipework sizes to determine their efficiency in a given context.
P1 Solve a Darcy-Weisback equation for a given pressure pipe system. **P2** Solve a Manning's equation for a given open channel flow situation.	**M1** Discuss the differences and similarities between different types of hydrodynamic systems and calculations.	
LO2 Develop practical solutions for the distribution of fluids within correctly sized pipes		
P3 Calculate the head loss for a given pipeline. **P4** Define pipe sizes for a given set of flow parameters.	**M2** Evaluate pipe sizes to determine the flow type that will occur.	
LO3 Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems		**D2** Critically analyse proposals for subsurface structures in response to the hydrostatic pressure in a given context.
P5 Evaluate a hydraulic condition in order to determine the parameters of the problem. **P6** Illustrate a proposed solution to a hydraulic problem, using drawings or models.	**M3** Compare proposed solutions to a hydraulics problem, highlighting the merits of different solutions.	
LO4 Calculate the hydrostatic pressure exerted on substructures for a given context		
P7 Calculate the pressure exerted on a foundation wall in a given context. **P8** Determine the pressure exerted on a subsurface floor in a given context.	**M4** Evaluate the ability of a given subsurface wall and floor to resist the forces exerted by liquid in a given context.	

Recommended Resources

Print resources

DOUGLAS, J. (1971), *Solution of Problems in Fluid Mechanics*, Pitman

DOUGLAS, J., GASIOREK, J., GASIOREK, J., SWAFFIELD, J. (2001), *Fluid Mechanics*, Addison-Wesley Longman Limited

WARD-SMITH, J. (2011), *Mechanics of Fluids*, Ninth Edition, CRC Press

WYNN, P. (2014), *Hydraulics for Civil Engineers*, Inst of Civil Engineers Pub

Web resources

https://www.cices.org	**Chartered Institution of Civil Engineering Surveyors** (Professional Body)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 8: Mathematics for Construction
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 31: Advanced Structural Design
- Unit 34: Further Mathematics for Construction
- Unit 45: Advanced Materials.

Unit 43: Advanced Surveying & Measurement

Level: 5

Credits: 15

Ofqual Code: Y/618/8120

Introduction

As technology advances, it is a means to enhance and improve the services that surveyors and civil engineers 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 the position of construction works are accurately controlled and monitored.

In this unit, students will use total station and Global Navigation Satellite System (GNSS). The unit focuses on instrument functionality to determine precise coordinate values and the processes required to produce industry-standard surveying outputs.

On successful completion of this unit, students will be able to setup a precise control network and combine the use of total station and GNSS functionality to produce accurate survey data for different construction uses.

Learning Outcomes

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

LO1 Explain the principles of GNSS, including modes of use, and relationships between coordinate systems

LO2 Conduct a 3D traverse survey of a control network to a ‘local grid’ to produce 3-dimensional coordinates, including corrections

LO3 Produce industry-standard survey output based on completion of a comprehensive topographic survey of landscape features and built structures, using total station and GNSS methods

LO4 Analyse the potential benefits and challenges of using total station and GNSS surveying methods, including sources of error.

Essential Content

LO1 **Explain the principles of GNSS, including modes of use, and relationships between coordinate systems**

Modes of occupation

Context and principles

System components

Communication and solutions

Modes of operation

Differential

Static

Real Time Kinematic (RTK)

Post processing Continuously Operating Reference Stations (CORS)

Transformations (localisation) and residual errors

LO2 **Conduct a 3D traverse survey of a control network to a 'local grid' to produce 3-dimensional coordinates, including corrections**

Total station methods of observation

Control networks

Local and national coordinate systems

Instrument settings, configuration and functionality

Closed 3D traverse (e.g., horizontal planes, vertical planes)

Production of 3D coordinate values and adjustments

LO3 **Produce industry-standard survey output based on completion of a comprehensive topographic survey of landscape features and built structures, using total station and GNSS methods**

Total station

Working whole to part

Instrument positioning and orientation to control

Set up methods – risks and best practice

Topographic survey mode – organisation of topographic data

Codes and attributes

GNSS

Modes of occupation and best practice

Limitations of use

Organisation of topographic data (e.g., codes, attributes)

Survey outputs and client deliverables

Data transfer

CAD based modelling

Building Information Modelling (BIM)

2D drawing production

Post-processing (e.g., analysis of data, visual processes, software)

LO4 **Analyse the potential benefits and challenges of using total station and GNSS surveying methods, including sources of error**

With total station

Control error and base lines

Instrument settings as a source for error (e.g., EDM settings, prism constant, atmospherics, ATR, remote operation, coordinate systems, user scale factor, point filters, data management)

Strengths and weaknesses of on-board functionality, i.e. assisted workflows

With GNSS

Expected and actual accuracy

Limitations of use

Transformation residual errors with selected control stations and best practice

Evaluation of ground length between total station and GNSS derived coordinates

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the principles of GNSS, including modes of use, and relationships between coordinate systems		**D1** Analyse the impact of transformation and residual errors on the accuracy of GNSS coordinates.
P1 Describe the context and principles of GNSS. **P2** Illustrate the relationships between coordinate systems in GNSS.	**M1** Assess the modes of operation in GNSS and their different uses.	
LO2 Conduct a 3D traverse survey of a control network to a 'local grid' to produce 3-dimensional coordinates, including corrections		**D2** Critically evaluate the efficiency of producing topographic survey data from 3D data, obtained via GNSS and total station, using CAD or BIM applications.
P3 Discuss the difference between local and national coordinate systems. **P4** Undertake a 3D traverse survey to obtain 3-dimensional coordinates and correction.	**M2** Assess the impact of instrument settings and configuration on the accuracy of a 3D traverse survey.	
LO3 Produce industry-standard survey output based on completion of a comprehensive topographic survey of landscape features and built structures, using total station and GNSS methods		
P5 Carry out a comprehensive topographic survey using GNSS and total station methods. **P6** Prepare industry-standard survey outputs, including location of landscape features and built structures.	**M3** Analyse the different levels of information and detail provided in CAD, BIM and 2D drawing output of survey data.	

Pass	Merit	Distinction
LO4 Analyse the potential benefits and challenges of using total station and GNSS surveying methods, including sources of error		**D3** Justify the selection of digital surveying tools and software, based on their accuracy and ability to provide suitable data.
P7 Assess the benefits and challenges of using total station and GNSS for surveying. **P8** Report on the sources of error and approaches to correction in the use of total station and GNSS for surveying.	**M4** Evaluate the use of total station and GNSS in surveying to identify best practice for their use.	

Recommended Resources

Print resources

IRVINE, W., MACLENNAN, F. (2006), *Surveying for Construction*, McGraw-Hill

SADGROVE, B., DANSON, E. (2007), *Setting-out Procedures for the Modern Built Environment*, Ciria

SCHOFIELD, W., BREACH, M. (2007), *Engineering Surveying, Sixth Edition*, CRC Press

UREN, J., PRICE, W. (2010), *Surveying for Engineers*, Palgrave Macmillan

Web resources

https://www.cices.org	**Chartered Institution of Civil Engineering Surveyors** (Professional Body)
https://www.ice.org.uk	**Institution of Civil Engineers** (Professional Body)
https://www.rics.org	**Royal Institution of Chartered Surveyors** (Professional Body)
https://www.tsa-uk.org.uk	**The Survey Association** (Professional Body)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 20: Site Supervision & Operations
- Unit 24: Principles of Off-site Construction
- Unit 25: Quantity Surveying Practice
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 41: Highway Engineering
- Unit 44: Maintenance & Operations
- Unit 46: Transport Systems in Buildings
- Unit 47: Advanced Building Information Modelling
- Unit 51: Advanced Construction Development & Prototyping
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction.

Unit 44: Maintenance & Operations

Level: 5

Credits: 15

Ofqual Code: D/618/8121

Introduction

The aim of this unit is to give students background knowledge and understanding of the maintenance and operations required in relation to the safe and efficient use of buildings, in both specific contexts and in 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 also 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 and 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:

LO1 Discuss the different parties involved in building maintenance and operations activities, their roles and responsibilities

LO2 Compare different types of building maintenance and the management approaches that support them

LO3 Demonstrate how Building Information Modelling (BIM) assists in managing maintenance and operations effectively and efficiently

LO4 Assess how maintenance and operations are managed as part of a wider business management strategy.

Essential Content

LO1 **Discuss the different parties involved in building maintenance and operations activities, their roles and responsibilities**

Design team

Architects

Planners

Surveyors

Construction team

Contractors

Subcontractors

Suppliers

Consultants

Engineers (e.g., structural, building services)

Project managers

Health and safety managers

Cost consultants

Operational team

Facilities managers

Building maintenance operatives

Stakeholders

Client

Developer

Tenants

Leaseholders

Investors

LO2 Compare different types of building maintenance and the management approaches that support them

Types of maintenance

Reactive maintenance

Planned maintenance

Cyclical maintenance

Routine maintenance

Proactive maintenance

Maintenance and cost

Maintenance cost vs replacement cost

Maintenance and asset value

Materials and systems

Structural maintenance

Cosmetic maintenance

Material requirements

Services maintenance

Statutory and legal requirements (e.g., health and safety, fire protection)

Frequency of maintenance

Maintenance and building lifecycle

LO3 Demonstrate how Building Information Modelling (BIM) assists in managing maintenance and operations effectively and efficiently

Building Information Modelling and Building Asset Modelling

Project Information Requirements (PIR) and Asset Information Requirements (AIR)

Project Information Model (PIM) and Asset Information Model (AIM)

Common Data Environment (CDE) and data management

Event triggers and response

Sustainable maintenance

Finance and management of budgets

Resources (hard and soft)

Health and 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 to ensure that efficiency and sustainability are achievable

People management

Recruiting staff

Developing staff

Managing teams

Managing staff conflict

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the different parties involved in building maintenance and operations activities, their roles and responsibilities</td><td rowspan="4">D1 Critically analyse how maintenance may be undertaken over a period of time while ensuring compliance with statutory regulations and legislation.</td></tr>
<tr><td>P1 Illustrate the different parties involved in building maintenance and operations.

P2 Discuss the roles and responsibilities that are required for building maintenance and operations.</td><td>M1 Evaluate the relationship between the design and construction team and the operational team in ensuring effective maintenance and operations.</td></tr>
<tr><td colspan="2">LO2 Compare different types of building maintenance and the management approaches that support them</td></tr>
<tr><td>P3 Compare the key principles of different types of maintenance and management, with reference to how these may work together for different materials and systems within a building.

P4 Discuss the relationship between building management strategy and building maintenance cost.</td><td>M2 Evaluate the advantages and disadvantages of each of the maintenance management approaches.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Demonstrate how Building Information Modelling (BIM) assists in managing maintenance and operations effectively and efficiently		
P5 Explain the concepts of project information and asset information in BIM and how management of this data enables building maintenance. **P6** Use building information data to illustrate how maintenance responds to different types of event triggers.	**M3** Explore the benefits and constraints of using an asset model for planning maintenance and operations programmes.	**D2** Critically evaluate the role of BIM in supporting sustainable practice in maintenance and operations, relating it to broader business practices and strategies.
LO4 Assess how maintenance and operations are managed as part of a wider business management strategy		
P7 Discuss the impacts of core business and facilities/maintenance management on one another on a day-to-day basis. **P8** Assess the role of managers in supporting staff and avoiding conflict as a part of effective maintenance operations.	**M4** Reflect on the contract parameters for facilities management and explain the implications on core business.	

Recommended Resources

Print resources

ATKIN, B., BROOKS, A. (2015), *Total Facility Management*, John Wiley & Sons

BOOTY, F. (2009), *Facilities Management Handbook*, Routledge

CHANTER, B., SWALLOW, P. (2008), *Building Maintenance Management*, John Wiley & Sons

HALL, F., GREENO, R. (2017), *Building Services Handbook*, Taylor & Francis

KLEMISCH, J. (2011), *Maintenance of Historic Buildings: A Practical Hanbook*, Routledge

OLANREWAJU, A., ABDUL-AZIZ, A. (2014), *Building Maintenance Processes and Practices*, Springer

WIGGINS, J. (2010), *Facilities Manager's Desk Reference*, John Wiley & Sons

WOOD, B. (2009), *Building Maintenance*, John Wiley & Sons

Web resources

https://www.iwfm.org.uk	**British Institute of Facilities Management** (Professional Body)
https://www.fmj.co.uk	**Facilities Management Journal** (General Reference)

Links

This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 11: Financial Management & Business Practices in Construction
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling.

Unit 45: Advanced Materials

Level: 5

Credits: 15

Ofqual Code: H/618/8122

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.

On 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 of the feasibility of innovative and smart materials in construction projects.

Learning Outcomes

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

LO1 Evaluate the characteristic properties that contribute to the mechanical functionality of materials

LO2 Examine failure mechanisms of different materials through intrinsic and extrinsic methods

LO3 Present a case study exploring innovative and smart materials and their role in sustainable construction

LO4 Analyse material selection and design strategies in either a structural or civil engineering environment.

Essential Content

LO1 Evaluate the characteristic properties that 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 (e.g., microscopy, chemical, physical and structural analysis, thermal techniques)

Competencies and limitations of testing methods

Material 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

Extrinsic failure (environmental)

Environmental interactions (e.g., erosion, freeze/thaw, factors leading to the failure of materials)

Human interactions (e.g., vandalism, wear, biological transfer)

Intrinsic failure (material)

Crystallography and fracture mechanics

Design faults

Assembly error

Material defects

Failure prevention mechanisms

Preventing or impeding environmentally induced failure of materials

Materials selection

Engineering design

Materials monitoring

Inspection strategies

LO3 **Present a case study exploring innovative and smart materials and their role in sustainable construction**

Innovative and smart materials

Composite materials (e.g., matrix composition, glass reinforced plastic (GRP), fibre-reinforced polymers (FRP), concretes, metals)

Innovative materials (e.g., aerogels, smart concrete, aluminium oxynitride glass)

Nanotechnology (e.g., photocatalytic concrete, nano-silica, carbon nanofibers, nano-calcite particles)

Property and energy change materials (e.g., 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

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

Project factors

Structural engineering (e.g., building type, building use, building scale, construction method, loading conditions)

Civil engineering (e.g., infrastructure type, scale, loading conditions, construction method)

Material factors

Material type (e.g., steel, concrete, timber, masonry, composites)

Testing evidence (e.g., strength in compression, strength in tension, impact resistance, expansion, heat/cold resistance)

Environmental factors

Exposure (e.g., temperature, freeze/thaw cycles, direct sunlight, wind, humidity, subsurface water)

Pollution (e.g., airborne chemicals, acid rain, CO2, CO)

Erosion (e.g., moving water, airborne grit/sand)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate the characteristic properties that contribute to the mechanical functionality of materials		
P1 Determine the properties and characteristics of materials based on data from testing. **P2** Evaluate how material characteristics are influenced by the forms in which materials are commonly available.	**M1** Assess the effects of different manufacturing methods in relation to material properties.	**D1** Critically analyse data from material characterisation techniques and how this informs material selection.
LO2 Examine failure mechanisms of different materials through intrinsic and extrinsic methods		
P3 Explore cause and effect of different modes of failure **P4** Discuss the differences between intrinsic and extrinsic failure in different materials.	**M2** Discuss methods of remedial or preventative action to enhance service life of different materials.	
LO3 Present a case study exploring innovative and smart materials and their role in sustainable construction		
P5 Discuss the role of innovative and smart materials in developing sustainable solutions. **P6** Produce a case study of innovative materials currently available or in use in the construction industry.	**M3** Analyse typical applications of smart materials, with reference to their characteristics and properties.	**D2** Evaluate the effectiveness of using a smart or innovative material as an alternative to a given structural element for a given project.
LO4 Analyse material selection and design strategies in either a structural or civil engineering environment		
P7 Specify a range of smart or innovative materials for the structural or design elements of a given project. **P8** Analyse the suitability of materials selected for a given design problem or structural element.	**M4** Assess the use of advanced materials or techniques to prevent structural failure and create energy efficient structures.	**D3** Justify the selection of smart or innovative materials based on their suitability for the project, addressing material and environmental factors.

Recommended Resources

Print resources

AHMED, A., STURGES, J. (2014), *Materials Science In Construction: An Introduction*, Routledge

BORESI, A., SCHMIDT, R. (2019), *Advanced Mechanics of Materials*, Wiley Global Education

CASINI, M. (2016), *Smart Buildings*, Woodhead Publishing

GANCHY, S. (2009), *Islam and Science, Medicine, and Technology*, The Rosen Publishing Group, Inc

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

SOMAYAJI, S. (2001), *Civil Engineering Materials*, Pearson College Division

SOUTSOS, M., DOMONE, P. (2017), *Construction Materials*, CRC Press

YUAN, Q., LIU, Z., ZHENG, K., MA, C. (2021), *Civil Engineering Materials*, Elsevier

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 14: Principles of Refurbishment
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 22: Scientific Principles for Building Services
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 34: Further Mathematics for Construction
- Unit 41: Highway Engineering
- Unit 42: Hydraulics.

Unit 46: Transport Systems in Buildings

Level: 5

Credits: 15

Ofqual Code: K/618/8123

Introduction

The success of today's modern high-rise buildings is owed to their ability to transport their occupants vertically and horizontally in a safe and efficient manner. This unit covers these systems in detail, along with their integration into the overall elements of the buildings that support 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 within a building. The principal person responsible for these access arrangements is often the building services engineer and it is their responsibility to ensure that these 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 in a building that would be installed by a specialist sub-contractor. Students will have the fundamental knowledge and skills needed to progress to a higher level of study in building services engineering.

Learning Outcomes

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

LO1 Discuss the functional requirements for circulation in a proposed building design

LO2 Determine traffic planning and equipment selection criteria for lifts, escalators and moving walkways for a given building design

LO3 Develop a design and installation strategy for escalators and moving walkways into a given building design

LO4 Present a design and installation strategy for lifts to support a given building design.

Essential Content

LO1 Discuss the functional requirements for circulation in a proposed building design

Clients' requirements

Private and public access arrangements

Goods deliveries

Desired circulation (e.g., capacity, access limits, circulation flows)

Disability access arrangement requirements (e.g., inclusive design, non-discrimination)

Sustainable design (e.g., energy use, materials)

Future expansion planning

Emergency evacuation policies (e.g., statutory requirements, health and safety)

Human factors

Volume and timing of circulation

Circulation zones

Alarm response (e.g., human reaction, time required for evacuation, speed of access, disabled access)

Occupancy (e.g., weight of occupancy, body sway)

Pedestrian access (e.g., speed of pedestrians, age and frailty)

Safety (e.g., slips, trips and falls, even flooring)

Wayfinding (e.g., signage locations, signage readability)

Cultural and religious influence (e.g., separation of sexes)

Personal influence (e.g., personal space, intimacy, social distancing)

Health and safety influence (e.g., social distancing, density of occupation)

LO2 Determine traffic planning and equipment selection criteria for lifts, escalators and moving walkways for a given building design

Planning and design

Building occupancy (e.g., hours of operation, peak congestion times)

Traffic patterns (e.g., vertical and horizontal traffic, circulation efficiency)

Building signage

Capacity (e.g., size of lift/escalator/walkway, number of users during peak times, speed of operation)

Waiting times (e.g., peak access wait, access and egress wait, round trip calculations)

Quality of service required (e.g., aesthetics, crowding limits, maximum heights, speeds)

Statutory requirements (e.g., building regulations, health and safety)

Escalators (e.g., inclination distance, stair width, speed)

Lifts (e.g., size of car, vertical travel distance, use, control)

Moving walkway (e.g., length of travel, speed, width, access/egress transition)

Fire and safety considerations (e.g., use during fire, emergency stop, materials)

Traffic simulation systems

Equipment selection

Design (e.g., pre-engineered off-the-shelf applications or custom designed)

Costs (e.g., capital expenditure, lifetime maintenance, statutory compliance)

Inspection and testing certification

Specialist considerations (e.g., hospital uses, heavy goods lifting, high-traffic environments)

Context considerations (e.g., lift shaft construction, overall building structure)

Aesthetic requirements (e.g., finishes, fixtures, handrails, bumpers, doors, frames)

Drive systems (e.g., energy requirements, emergency stop procedures, safety devices, single direction or reversible)

Maintenance access (e.g., service ‘down-time’, redundancy, disruption)

LO3 **Develop a design and installation strategy for escalators and moving walkways into a given building design**

Design factors

Building type (e.g., public, private, residential, commercial, industrial)

Building scale (e.g., horizontal travel distances, floor-to-floor heights)

Building occupancy (e.g., hours of operation, peak congestion times)

Moving walkway (e.g., length of travel, speed, width, access/egress transition)

Escalators (e.g., inclination distance, stair width, speed)

Aesthetics (e.g., materials, finishes, quality)

Structural support requirements

Building structure

Installation structure (e.g., interface between escalator/walkway and building structure)

Structural connections

Building services

Energy requirements (e.g., electrical load, motor type, drive system, emergency shutdown, safety devices)

HVAC requirements (e.g., heating load, ventilation requirements)

Acoustic requirements (e.g., equipment noise, dampening, vibration)

Signage

Health and safety

Safe installation (e.g., manual lifting, working at height, electrical safety)

Fire precaution measures (e.g., emergency use, emergency stop)

Testing and commissioning

LO4 **Present a design and installation strategy for lifts to support a given building design**

Design factors

Building type (e.g., public, private, residential, commercial, industrial)

Building scale (e.g., horizontal travel distances, floor-to-floor heights)

Building occupancy (e.g., hours of operation, peak congestion times)

Lift type (e.g., passenger lift, goods and passenger lifts, permanent or construction lift, goods only lift, observation lift in tall structures, service lift, motor vehicle lifts)

Drive system (e.g., hydraulic, electric traction, counterweight driven, suspension and roping, braking systems, speed control)

Car design (e.g., single or double-decker, single point of entry or dual door, materials, finishes)

Signage

Structural support requirements

Building structure

Installation structure (e.g., lift shaft, interface with building structure, prefabricated or in situ)

Structural connections

Building services

Electrical (e.g., mains cable installation, electrical load, isolation, lighting, ventilation, DC and AC drive systems, emergency lighting, standby power)

Sustainability

Access and maintenance

Plant rooms

CCTV requirements

Lift controls

Control type (e.g., single lift, multiple lift, group traffic)

Controller technology for call systems

Door operation controls

Health and safety

Remote alarms

Emergency phone systems

Fire and evacuation control by authorities

Statutory requirements

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the functional requirements for circulation in a proposed building design		**D1** Critically analyse the impact of health and safety on the selection for transport systems within buildings.
P1 Assess stakeholder requirements for movement within a building. **P2** Explain the factors that affect the selection of a transportation system.	**M1** Compare stakeholders' needs with statutory requirements for circulation systems in buildings.	
LO2 Determine traffic planning and equipment selection criteria for lifts, escalators and moving walkways for a given building design		
P3 Assess the client and functional requirements for building transport in a given design. **P4** Review equipment for lifts, escalators and moving walkways to determine their suitability.	**M2** Evaluate selected equipment in meeting the requirements of client and functional needs.	
LO3 Develop a design and installation strategy for escalators and moving walkways into a given building design		**D2** Justify a design and installation strategy for lifts, escalators and moving walkways within a given building, highlighting how these meet client needs and statutory requirements.
P5 Prepare design drawings to support the installation of escalators and moving walkways. **P6** Design structural details to support the installation of escalators and moving walkways within a given building.	**M3** Integrate mechanical and electrical systems for escalators and moving walkways with building services installations for a given building.	
LO4 Present a design and installation strategy for lifts to support a given building design		
P7 Develop design and technical drawings to support the installation of lifts within a given building. **P8** Present a lift design and installation strategy for a given building.	**M4** Analyse the structural and mechanical requirements to support the installation of lifts within a given building.	

Recommended Resources

Print resources

BARNEY, G. (2003), *Elevator Traffic Handbook*, Taylor & Francis

EMMITT, S. (2018), *Barry's Advanced Construction of Buildings*, John Wiley & Sons

MARKON, S., KITA, H., KISE, H., BARTZ-BEIELSTEIN, T. (2010), *Control of Traffic Systems in Buildings*, Springer

STRAKOSCH, G., CAPORALE, R. (2010), *The Vertical Transportation Handbook*, John Wiley & Sons

Web resources

https://www.bsria.com	**Building Services Research and Information Association** (Professional Body)
https://www.cibse.org	**Chartered Institution of Building Services Engineers** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 17: Civil Engineering Technology
- Unit 18: Principles of Electrical Design & Installation
- Unit 19: Principles of Structural Design
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 49: Advanced Electrical Design & Installation
- Unit 50: Building Management Systems.

Unit 47: Advanced Building Information Modelling

Level: 5

Credits: 15

Ofqual Code: M/618/8124

Introduction

The aim of this unit is to give students an understanding of the detailed processes that support and guide construction professionals in the context of Building Information Modelling (BIM). Students will 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.

Students will also explore in detail the relevant changes to existing documentation and information in a project, and how this information is developed across the various stages of a project. There is series of standards that support BIM and students will begin to determine their relevance and utilise them in a BIM process.

The knowledge and skills that students gain in this unit will give them an understanding of the context of BIM in the construction industry and they will be able to relate this to further study or to the realities of today's workplace. Students will 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:

LO1 Explain the importance of information management in construction projects and how different parties are involved in the BIM process

LO2 Assess the Organisational Information Requirements (OIR) and prepare the Exchange Information Requirements (EIR) for a given project

LO3 Analyse the relationship between Project Information Requirements (PIR) and the Project Information Model (PIM) for a given construction project

LO4 Use available data and information to prepare the Asset Information Model (AIM) based on the Asset Information Requirements for a given construction project.

Essential Content

LO1 **Explain the importance of information management in construction projects and how different parties are involved in the BIM process**

BIM and information management

ISO 19650

Definitions (e.g., information management, asset, project delivery, asset operation)

Roles & responsibilities

Appointing party (e.g., client, asset owner)

Lead appointed party (e.g., main consultant, project manager, information exchange accountability)

Appointed party (e.g., information ‘generators’ – contractor, subcontractor, supplier, consultant)

Project team (e.g., everyone involved in the project)

Delivery team (e.g., lead appointed party and task teams)

Task team(s) (e.g., person or group performing a specific task – design team, curtain wall consultant, steel fabricator)

Information requirements cycle

Define

Appoint

Plan

Deliver

Check

Use

Learn (leading back to define)

LO2 **Assess the Organisational Information Requirements (OIR) and prepare the Exchange Information Requirements (EIR) for a given project**

Organisational Information Requirements (OIR)

High-level business-related requirements

Appointing party organisational objectives (e.g., statement of need)

Pre-contract BIM Execution Plan (BEP)

Post-contract BIM Execution Plan (BEP)

Exchange Information Requirements (EIR)

Technical information (e.g., software, data exchange formats, level of detail, training requirements)

Managerial information (e.g., standards, stakeholders and responsibilities, security, coordination and clash detection, collaboration process, compliance plan, model review, health and safety, data segregation and model management, asset information delivery strategy)

Commercial information (e.g., timing of 'data drops', client strategic purpose, BIM project deliverables, BIM competence assessment)

Common Data Environment (CDE)

Relationship to Exchange Information Requirements

Information states (e.g., work in progress, shared, published, archived)

Metadata (e.g., revision code, status, code, classification)

Classification systems (e.g., Uniclass, Omniclass, CI/SfB)

Software (e.g., vendors, cloud-based, on-premises)

Process (e.g., information sharing, managing revisions, metadata and process management)

Role of the information manager

LO3 **Analyse the relationship between Project Information Requirements (PIR) and the Project Information Model (PIM) for a given construction project**

Project Information Requirements (PIR)

High-level project-related requirements

Project delivery phase

Project scope and business case

Strategic brief

Key stakeholders

Project tasks

Key decision points (e.g., project milestones)

Decisions required from appointing party at key decision points

Information required to enable appointing party to make decisions

Project Information Model (PIM)

Project delivery phase

Management within the CDE

Relationship to EIR and PIR

Federated building information models (e.g., graphical data and formats, non-graphical data, documentation)

Structured data (e.g., COBie files, schedules)

Reports and other documentation

LO4 **Use available data and information to prepare the Asset Information Model (AIM) based on the Asset Information Requirements for a given construction project**

Asset Information Requirements (AIR)

Information required for the lifecycle of the asset (e.g., to operate the asset, to maintain the asset)

Managerial information (e.g., type of asset, identification information, location, floor area, warranties, maintenance and inspection schedules, hazardous materials or waste, end of life process, emergency plans)

Commercial information (e.g., description, function, supplier details, lead time, condition, KPIs, spares)

Technical information (e.g., engineering data, design parameters, commissioning dates and data, operational data, finishes, service requirements, outputs)

Asset Information Model (AIM)

Operational phase

Operating costs (e.g., energy use, replacement, repair, maintenance)

Management within CDE

Relationship to Asset Information Requirements

From PIM to AIM

The single source of ‘truth’ about a built asset

AIM content (e.g., graphical data, non-graphical data, ownership information, rights and restrictions, surveys, work carried out, operational performance information, condition information)

Changes to AIM (e.g., event triggers, updating AIM)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the importance of information management in construction projects and how different parties are involved in the BIM process		**D1** Critically evaluate the ways in which a clear information management system enables effective project delivery and asset operations.
P1 Discuss the key features of ISO 19650 and information management for construction projects. **P2** Illustrate the relationships between different parties and teams for a BIM-enabled project.	**M1** Analyse the responsibilities of different teams and parties through the information requirements cycle.	
LO2 Assess the Organisational Information Requirements (OIR) and prepare the Exchange Information Requirements (EIR) for a given project		
P3 Develop Organisational Information Requirements for a given construction project. **P4** Produce the Exchange Information Requirements for a given construction project to support Organisational Information Requirements.	**M2** Specify the Common Data Environment to support the Exchange Information Requirements for a given construction project.	

Pass	Merit	Distinction
LO3 Analyse the relationship between Project Information Requirements (PIR) and the Project Information Model (PIM) for a given construction project		
P5 Define the Project Information Requirements to support the delivery phase of a given construction project. **P6** Analyse the way that Project Information Requirements inform the development of the Project Information Model for a given construction project.	**M3** Evaluate the different types of information that must be developed for the Project Information Model and how they support the delivery phase of the project.	**D2** Critically analyse the use of BIM data to support the entire lifecycle of a construction project through delivery and operation.
LO4 Use available data and information to prepare the Asset Information Model (AIM) based on the Asset Information Requirements for a given construction project		
P7 Discuss the role of BIM data in supporting the operational phase and the potential cost benefits of an accurate Asset Information Model. **P8** Compile the materials required for an Asset Information Model of a completed construction project, based on the Asset Information Requirements.	**M4** Evaluate the process of updating an Asset Information Model in response to different event triggers.	

Recommended Resources

Print resources

BALLAST, D. (2009), *Architect's Handbook of Construction Detailing*, John Wiley & Sons

FAIRHEAD, R. (2014), *Information Exchanges*, Riba Publications Limited

HOLZER, D. (2016), *The BIM Manager's Handbook*, John Wiley & Sons

MCMULLAN, R. (1998), *Environmental Science in Building*, Macmillan International Higher Education

SACKS, R., EASTMAN, C., LEE, G., TEICHOLZ, P. (2018), *BIM Handbook*, John Wiley & Sons

SAXON, R. (2016), *Bim for Construction Clients*, NBS

SHEPHERD, D. (2019), *The BIM Management Handbook*, Routledge

Web resources

https://www.theb1m.com	**The B1M** (General Reference)
https://www.bimtaskgroup.org	**The BIM Task Group** (General Reference)
https://www.bimtaskgroup.org	**The BIM Task Group – 'COBie UK 2012'** (General Reference)
https://plannerly.com/	**ISO 19650 Webinar** (Training)
https://www.thenbs.com/knowledge/	**ISO 19650 – A Global Opportunity** (Training)
https://www.thenbs.com	**NBS – 'BIM (Building Information Modelling)'** (General Reference)
https://www.iso.org	**Webinar BIM Information Management – Introduction to ISO 19650** (Training)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects.

Unit 48: Thermofluids & Acoustics

Level: 5

Credits: 15

Ofqual Code: T/618/8125

Introduction

The study of thermofluids is critical to the design, specification and operation of building services engineering systems. In this unit, students will explore the key features of thermofluids, heat transfer, thermodynamics, fluid mechanics and combustion, and their calculation and application. Understanding how to calculate and manage heat transfer will give students key knowledge that will enable them to work on a range of different systems for heating and refrigeration.

Students will also 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, learn 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:

LO1 Use dimensional analysis to determine units in building services systems

LO2 Discuss the principles of heat and vapour transfer in building services systems

LO3 Evaluate the performance of refrigeration plants and heat exchangers

LO4 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 (e.g., 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 (e.g., pump/fan laws, Darcy'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 (e.g., 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 (e.g., flat surfaces, cylindrical surfaces)

Free and forced convection and boundary layer

Temperature parameters (e.g., mean, bulk, Arithmetic mean temperature difference (AMTD), Log Mean Temperature Difference (LMTD))

Application of dimensionless groups

Heat transfer coefficients

Heat flux

Radiation

Surface characteristics (e.g., reflectivity, transmissivity, absorptivity, emissivity)

Electromagnetic radiation (e.g., 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 (e.g., asymmetric radiation, plane radiant temperature, vector radiant temperature)

Solar radiation (e.g., solar constant, solar intensity on surfaces)

Vapour transfer

Diffusion

Permeability

Vapour resistivity

Moisture transfer

Formation and modes of condensation (e.g., 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 (e.g., counter flow, parallel flow)

Heat exchange calculations (e.g., 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 (e.g., formulae, tables, charts)

Mass flow rates

Input power

Capacity

Efficiency

Coefficient of performance

Theoretical/actual cycle arrangements

Ideal/actual pressure-volume diagrams (e.g., reciprocating compression devices, roto-dynamic compression devices)

Compression and expansion curves (e.g., isothermal, adiabatic, polytropic, open and closed systems)

First Law of Thermodynamics (e.g., 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 (e.g., 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 (e.g., 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 (e.g., sound reduction index, insulation principles)

Control of noise

Attenuation characteristics of materials

Components and systems

Acoustic enclosures

Noise control design solutions (e.g., pipework, ductwork, grilles, diffusers, prime movers)

Compressors

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Use dimensional analysis to determine units in building services systems		
P1 Use dimensional analysis to determine units, dimensions and dimensionless groups. **P2** Identify dimensions, units and constants necessary to complete calculations for building services.	**M1** Apply the outcomes of dimensional analysis to the design and specification of building services systems.	**D1** Critically analyse the different outcomes of calculations using dimensionless parameters, highlighting their use in building services.
LO2 Discuss the principles of heat and vapour transfer in building services systems		
P3 Discuss the principles of conductive, convective and radiant heat transfer through building services equipment and structures. **P4** Explain the process of vapour transfer through building structures and the efficiency of building services equipment.	**M2** Assess a building services installation to determine the mechanism and performance of heat transfer through measurement and calculation.	**D2** Evaluate the modes of condensation used in building services equipment and the impact of heat and vapour transfer on human comfort in buildings.

Pass	Merit	Distinction
LO3 Evaluate the performance of refrigeration plants and heat exchangers		
P5 Evaluate the performance of refrigeration plant and heat pumps through the application of scientific principles. **P6** Analyse the performance of heat exchangers used in building services.	**M3** Compare the efficiency and performance of different forms of refrigeration plant, heat pumps and heat exchangers through measurement and calculation.	**D3** Critically analyse the relationship between the performance and efficiency of heating or refrigeration plant and the acoustic environment.
LO4 Design acoustic environments through the control of noise		
P7 Explain the design criteria for acoustic environments. **P8** Design effective acoustic environments for building services installations.	**M4** Evaluate, through measurement and calculation, the relative benefit of different forms of sound attenuation, dampening and absorption on reducing noise from building services installations.	

Recommended Resources

Print resources

CHADDERTON, D. (2014), *Air Conditioning*, Routledge

CHADDERTON, D. (2004), *Building Services Engineering*, Routledge

GREENO, R. (2014), *Building Services, Technology and Design*, Routledge

HALL, F., GREENO, R. (2017), *Building Services Handbook*, Taylor & Francis

MCDOWELL, R., MONTGOMERY, R. (2011), *Fundamentals of HVAC Control Systems*, American Society of Heating Refrigerating and Air-Conditioning Engineers

MOSS, K. (2002), *Heat and Mass Transfer in Building Services Design*, Routledge

OUGHTON, D., HODKINSON, S., BRAILSFORD, R. (2014), *Faber & Kell's Heating and Air-Conditioning of Buildings*, Routledge

Web resources

https://www.bsria.com	**The Building Regulations Approved Documents (UK)** (General Reference)
https://www.bsria.com	**Building Services Research and Information Association** (Professional Body)
https://www.cibse.org	**Chartered Institution of Building Services Engineers** (Professional Body)
https://www.engineeringtoolbox.com	**The Engineering Toolbox** (General Reference)

Links

This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 22: Scientific Principles for Building Services
- Unit 34: Further Mathematics for Construction
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 42: Hydraulics.

Unit 49: Advanced Electrical Design & Installation

Level: 5

Credits: 15

Ofqual Code: A/618/8126

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 that are suitable to the application but which are also safe and sustainable. The overall aim of this unit is to support students in developing 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 and health and 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. Students will also have the advanced knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

LO1 Explain the principles and equipment associated with power and distribution systems, electromagnetic compatibility and electrical services

LO2 Discuss the protective measures necessary for the safe installation and operation of electrical systems

LO3 Design an electrical distribution plan for a complex non-domestic building

LO4 Present a report on the national, regional and local standards for sustainability, technical and health and safety regulations that apply to specific building types.

Essential Content

LO1 **Explain the principles and equipment associated with power and distribution systems, electromagnetic compatibility and electrical services**

Electrical distribution

Substations and transformers

Distribution and branch panels

High voltage switch gear

Vertical supply system (e.g., rising main)

Horizontal supply (e.g., branch circuits, distribution at floor level)

Power cables and their application

Grounding systems

Use of renewable sources

Electromagnetic compatibility (EMC)

Causes of electromagnetic interference

System protection

Compliance with EMC installation rules

Electrical equipment and fixtures

Electrical wiring

Switchgear (e.g., manual switches, automatic switching)

Data and communications (e.g., network cabling, computers, telephones)

HVAC systems

Building management systems (BMS)

Building energy management system (BEMS)

Specialist equipment (e.g., factory equipment, medical equipment, servers)

Energy efficiency of equipment and fixtures

LO2 **Discuss the protective measures necessary for the safe installation and operation of electrical systems**

Contact protection

Direct contact

Indirect contact

Electrical shock protection

Normal conditions

Fault conditions

Overvoltage protection

Atmospheric overvoltage

Switching overvoltage

LO3 **Design an electrical distribution plan for a complex non-domestic building**

Building type/use

Residential (e.g., multi-occupancy, apartments, flats)

Commercial (e.g., office buildings, shopping centres)

Cultural (e.g., museums, theatres, stadiums, exhibition halls)

Industrial (e.g., factories, warehouses, garages)

Medical/scientific (e.g., hospitals, clinics, laboratories)

Power requirements

Single phase vs three phase

Loads (e.g., individual loads, emergency loads, area loads, activity loads)

Power source (e.g., primary, standby, emergency)

Equipment requirements

Lighting

Mechanical equipment (e.g., HVAC, lift motors, automatic doors)

Data and communication equipment

Specialist equipment (e.g., medical devices, factory machinery, theatre lighting)

Planning for future demand

LO4 **Present a report on the national, regional and local standards for sustainability, technical and health and safety regulations that apply to specific building types**

Standards

International standards (e.g., ISO, IEC)

National, regional and local standards

Professional standards and codes of practice

Sustainability standards (e.g., greenhouse gas emissions from generation, use of materials)

Legislation

Building regulations

Health and safety regulations

Electrical equipment (safety) regulations

Commissioning

Lighting levels

Electrical supply, generators, uninterruptible supply equipment

Distribution board, metering, switchgear

Earthing and bonding

Protective devices

Circuits, fuses, breakers, isolation

Communications/data equipment, wiring

Appropriate signage, protection

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the principles and equipment associated with power and distribution systems, electromagnetic compatibility and electrical services		**D1** Analyse the potential for electrical shock and overvoltage related to the different elements of electrical supply, distribution and use of equipment in buildings.
P1 Discuss the principles and equipment used in electrical distribution for buildings. **P2** Explain the causes of, and possible protection against, electromagnetic interference.	**M1** Analyse the relationship between electrical equipment and fixtures, and electromagnetic interference.	
LO2 Discuss the protective measures necessary for the safe installation and operation of electrical systems		
P3 Explain the different forms of electrical shock and overvoltage. **P4** Describe the methods of protection available to ensure safe installation and operation of electrical systems.	**M2** Illustrate the protective measures necessary for normal and fault conditions in specific systems.	

Pass	Merit	Distinction
LO3 Design an electrical distribution plan for a complex non-domestic building		**D2** Justify the design of an electrical power distribution system and the specification of equipment in relation to statutory regulations and health and safety.
P5 Evaluate building use, power requirements and equipment to inform a design for electrical distribution. **P6** Calculate electrical loads and suitable cabling sizes for an electrical distribution plan.	**M3** Specify correctly sized distribution equipment for an electrical distribution plan.	
LO4 Present a report on the national, regional and local standards for sustainability, technical and health and safety regulations that apply to specific building types		
P7 Review the different types of standards associated with the design and installation of electrical systems that promote sustainability. **P8** Explain the role of regulations in ensuring the safe installation, commissioning and operation of electrical systems.	**M4** Evaluate the relationship between local, regional and national standards related to electrical system design and installation.	

Recommended Resources

Print resources

AECOM (2020), *Spon's Mechanical and Electrical Services Price Book 2021*, CRC Press

AL-SHEMMERI, T., PACKER, N. (2021), *Building Services Engineering*, John Wiley & Sons

CHADDERTON, D. (2004), *Building Services Engineering*, Routledge

GREENO, R. (2014), *Building Services, Technology and Design*, Routledge

JOHRI, H., JOHRI, H. (2010), *Electrical Installations in Building*, K W Publishers Pvt Limited

LINSLEY, T. (2013), *Advanced Electrical Installation Work*, Routledge

PORTMAN, J. (2016), *Building Services Engineering*, John Wiley & Sons

RIGBY, B. (2013), *Design of Electrical Services for Buildings*, Routledge

Links

This unit links to the following related units:

- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 48: Thermofluids & Acoustics
- Unit 50: Building Management Systems.

Unit 50: Building Management Systems

Level: 5

Credits: 15

Ofqual Code: F/618/8127

Introduction

The earliest examples of building management systems (BMS) 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, BMS 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 it can also monitor energy use and contribute to energy conservation. Incorporating Energy Demand Management (EDM) into the BMS 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 front door.

The aim of this unit is for students to explore the rapidly growing range of services provided by BMS technology and to assess its contribution to the renewable energy debate. Students also have the opportunity to apply their research by carrying out the design of a BMS.

On successful completion of this unit, students will be conversant with current and emerging BMS technologies. They will also have developed the skills necessary to evaluate the benefit of a BMS and be able to apply their theoretical knowledge to a real-life installation.

Learning Outcomes

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

LO1 Discuss the technologies and applications used in building management systems

LO2 Assess how a building energy management system (BEMS) can optimise cost and energy usage

LO3 Evaluate the potential benefits in cost and sustainability through the use of BMS and BEMS technologies

LO4 Specify a building management system suitable for a small multi-zone, non-residential building.

Essential Content

LO1 **Discuss the technologies and applications used in building management systems**

General categories

Centralised system (e.g., a single central processing unit (CPU))

Distributed Intelligence Systems (e.g., intelligent ‘outstations’ with communications channels)

SMART buildings (Self-Monitoring Analsysis and Reporting Technology)

Internet of Things (IOT)

Applications

Lighting

HVAC

Fire and smoke detection and alarms

Security

ICT

Lifts

Shading devices

Energy use (e.g., smart meters, adaptive energy management)

System structure

Server (coordinates data received from sensors and issues commands to controllers)

Sensors (measures local conditions and supplies data to server)

Controllers (adjusts local equipment in response to signals from server)

Uninterruptible Power Supplies (UPS)

System integration

Local systems

Cloud and web applications

Mobile apps

Protocols (e.g., SOAP, XML, BACnet, KNX)

LO2 Assess how a building energy management system (BEMS) can optimise cost and energy usage

Building Energy Management Systems (BEMS) vs Building Management System (BMS)

Specialisation (e.g., BEMS is for energy only, while BMS may cover different systems)

Real-time monitoring and action (e.g., dynamic system)

Monitoring

Energy consumption

User behaviour

Energy use patterns

Time of use (e.g., large-scale energy costs fluctuate based on time of day and demand)

Cyclical/seasonal factors (e.g., different energy needs for different times of year)

Humidity

Weather data

Control

HVAC control (e.g., system adjustments based on weather, building/room occupancy, ambient temperature)

Lighting (e.g., automatic lights-off for unoccupied areas, light intensity response to ambient light)

Energy storage (e.g., store energy during periods of low-cost and use this to offset use during period of high cost)

LO3 Evaluate the potential benefits in cost and sustainability through the use of BMS and BEMS technologies

Legislation, regulation and standards

Building regulations

Governmental targets

Institutional targets

National and International standards (e.g., ISO 50001, ISO 52000, ISO/TS 50008)

Sustainability

Reduced energy consumption (e.g., automatic control of lighting and heating to avoid use in unoccupied areas)

Reduced reliance on fossil fuels (e.g., integrating renewable energy sources/systems)

Balanced energy use (e.g., limit high-demand conditions through energy storage and management)

Optimise passive systems (e.g., automatic control of passive cooling and ventilation when building demands are lower)

Cost

Installation cost vs return on investment

New build installation or retrofit system

Reduced maintenance cost (e.g., managed use of plant/equipment reduces load and wear)

Reduced time of use costs (e.g., power storage when lower utility cost)

Related expenditure (e.g., insulation upgrade to existing buildings, need to update plant/equipment/fixtures)

LO4 **Specify a building management system suitable for a small multi-zone, non-residential building**

Project information

Client requirements

Building use (e.g., commercial, industrial, cultural)

Building scale

Building construction (e.g., external wall construction, roof construction, window/glazing types)

Building services (e.g., HVAC systems, electrical supply, water supply)

Regulations and standards

Health and safety

Building regulations

Manufacturing certifications

Design factors

Building zones

Human comfort requirements (e.g., heating/cooling levels, lighting levels, ventilation requirements)

System design/specification

Overall strategy

Components (e.g., sensors, controllers, servers, UPS)

Protocols and compatibility (e.g., ensuring all components are compatible)

Potential savings (e.g., cost, energy consumption)

Commissioning process

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the technologies and applications used in building management systems		**D1** Evaluate the integration of building management system and building energy management system in providing an overall building management strategy.
P1 Discuss the principles of building management system. **P2** Explain the different components and approaches to system integration in building management systems.	**M1** Compare the use of different protocols and their interoperability in building management systems.	
LO2 Assess how a building energy management system (BEMS) can optimise cost and energy usage		
P3 Explain the differences between a BEMS and BMS. **P4** Discuss how a BEMS can lead to lower energy usage.	**M2** Assess different strategies for the control of energy use and consumption.	
LO3 Evaluate the potential benefits in cost and sustainability through the use of BMS and BEMS technologies		**D2** Justify the design and specification of a BMS/BEMS installation with regard to its impact on sustainability and cost.
P5 Explain the role of legislation, regulation and standards that support BMS/BEMS. **P6** Analyse the ways in which a managed building can lead to lower costs and greater sustainability.	**M3** Illustrate the relationship between cost and return on investment for new-build or retrofit installation of a BMS/BEMS.	
LO4 Specify a building management system suitable for a small multi-zone, non-residential building		
P7 Examine project information to define requirements for a BMS/BEMS installation. **P8** Design and specify a BMS/BEMS installation for a small multi-zone, non-residential building.	**M4** Compare different strategies for a BMS/BEMS installation to determine optimised performance of components and overall system.	

Recommended Resources

Print resources

BLOKDYK, G. (2020), *Building Management Systems A Complete Guide – 2020 Edition*, 5starcooks

CIBSE, (2007*), CIBSE Guide H: Building Control Systems*, Routledge

HARRIS, D. (2016), *A Guide to Energy Management in Buildings*, Taylor & Francis

LEVERMORE, G. (2013), *Building Energy Management Systems*, Routledge

LITTLEWOOD, J., SPATARU, C., HOWLETT, R., JAIN, L. (2017), *Smart Energy Control Systems for Sustainable Buildings*, Springer

SINOPOLI, J. (2009), *Smart Buildings Systems for Architects, Owners and Builders*, Butterworth-Heinemann

Web resources

https://www.cdbb.cam.ac.uk	**Centre for Digital Built Britain** (General Reference)
https://www.thenbs.com	**The NBS Knowledge** (General Reference)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 30: Project Management
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 46: Transport Systems in Buildings
- Unit 49: Advanced Electrical Design & Installation.

Unit 51: Advanced Construction Development & Prototyping

Level: 5

Credits: 30

Ofqual Code: J/618/8128

Introduction

Prototypes, whether full scale, models or components of a system, provide means by which design and manufacturing processes can be tested and evaluated. Through the making of prototypes, design, technical and cost issues can be resolved while at the same time evaluating aesthetic characteristics and market factors.

The rise of Modern Methods of Construction, particularly off-site approaches, has increased the need and value of prototyping in construction. Whether developing a panelised system, a volumetric approach or prefabricated units, the success of a manufactured component relies on its design and production being controlled and predictable. To achieve the necessary level of precision and reliability, prototypes are used to refine the outcome and optimise processes.

This unit supports students in bringing together their design, technical and process knowledge in the development of prototypes for construction using modern methods.

Learning Outcomes

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

LO1 Evaluate a design proposition to identify prototyping opportunities

LO2 Develop prototypes for a manufactured construction solution through iterative testing

LO3 Create a final prototype through the integration of resolved component, assembly and system solutions

LO4 Present an off-site manufacturing solution based on prototype development and evaluation.

Essential Content

LO1 Evaluate a design proposition to identify prototyping opportunities

Design evaluation

Typology

Material

Method of production

Design aims

Stakeholder requirements

Adaptability/customisation (e.g., deconstructability, long life, 'loose fit')

Prototypes

Scale (e.g., model, full-scale)

Component prototype

Assembly prototypes

System prototypes

LO2 Develop prototypes for a manufactured construction solution through iterative testing

Testing types

Performance testing (e.g., air infiltration, water ingress, weathering, energy efficiency, passive strategies, carbon emissions)

Safety testing (e.g., fire retardant, flame spread, fire compartmentation, means of escape, structural integrity.)

Fault-finding

Operational testing

Test rigs

Testing centres

Test reporting

Parameters

Process

Results

Actions

LO3 **Create a final prototype through the integration of resolved component, assembly and system solutions**

Final prototype

Design modifications

Manufacturing modifications

Materials

Components

Assemblies

Systems

Production model

Volume production

Material management

Sustainability

LO4 **Present an offsite manufacturing solution based on prototype development and evaluation**

Solution

Final design

Solution development process (e.g., prototyping process, testing process)

Manufacturing features

Profit (e.g., development cost vs return on cost)

Presenting solution

Prototype scale (e.g., model vs full-scale, mock-up vs functional)

Reports/results (e.g., cost reports, testing reports, etc.)

Market (e.g., solution to meet market demand, market testing, consumer testing)

Presentation

Audience (e.g., technical, professional, financial, stakeholder)

Format (e.g., written report, audio-visual, etc.)

Supporting/defending (e.g., reference material, research, design/testing)

Feedback/reflection

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate a design proposition to identify prototyping opportunities		**D1** Critically analyse the results of testing different forms of prototype to refine design propositions and technical developments.
P1 Evaluate a design proposition to determine areas for manufacturing research. **P2** Identify prototyping opportunities, related to a design proposition, to test manufacturing potential.	**M1** Analyse the potential benefits of different forms of prototyping in relation to a design proposition.	
LO2 Develop prototypes for a manufactured construction solution through iterative testing		
P3 Develop different forms of prototype to test specific features of a design and manufacturing solution. **P4** Iteratively test different forms of prototype to determine levels of performance, safety and operation.	**M2** Prepare detailed reports on the results of prototyping and testing to determine actions for iterative development and re-testing.	
LO3 Create a final prototype through the integration of resolved component, assembly and system solutions		**D2** Critically evaluate the potential success of a manufacturing solution, based on the data gathered through prototyping and testing components, assemblies and systems.
P5 Create a final prototype building, based on development prototypes. **P6** Discuss the design modifications resulting from prototyping and testing.	**M3** Analyse the manufacturing modifications required for a final building prototype to be achieved through a specific production model.	
LO4 Present an off-site manufacturing solution based on prototype development and evaluation		
P7 Present a detailed solution for the manufacture of a given building, component or system. **P8** Integrate cost and market information into a manufacturing solution.	**M4** Justify a manufacturing solution, based on prototype, research, reporting and data.	

Recommended Resources

Print resources

CIBSE (2006), *Environmental Design*, CIBSE

FAIRHEAD, R. (2014), *Information Exchanges*, Riba Publications Limited

LYONS, A. (2014), *Materials for Architects and Builders*, Routledge

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

MARSHALL, D., WORTHING, D., DANN, N., HEATH, R. (2013), *The Construction of Houses*, Taylor & Francis

MARSHALL, D., WORTHING, D., HEATH, R. (2013), *Understanding Housing Defects*, Taylor & Francis

RILEY, M., COTGRAVE, A., HOWARD, C. (2008), *House Construction*, Palgrave Macmillan

RILEY, M., COTGRAVE, A. (2009), *Construction Technology 2: Industrial and Commercial Building*, Macmillan International Higher Education

SINOPOLI, J. (2009), *Smart Buildings Systems for Architects, Owners and Builders*, Butterworth-Heinemann

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4001CE: Construction Design Project Civil Engineering (Pearson-set)
- Unit 2: Construction Technology
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 47: Advanced Building Information Modelling
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction.

Unit 52: Advanced Housing Design & Specification

Level: 5

Credits: 15

Ofqual Code: L/618/8129

Introduction

In this unit, students will explore the role of design and specification in the production of housing. The emphasis in this unit is on expanding the knowledge and awareness of the processes of design, information production and construction, integrating the work of other professionals and consultants, to ensure high-quality design output.

Students will develop strategies and propositions that achieve stakeholder needs by addressing design, technical, environment and cost challenges.

By the end of this unit, students will have a greater awareness of managing their own design process as well as an understanding of how other professionals contribute to design and specification.

Learning Outcomes

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

LO1 Review a given site and client brief to develop a housing design proposition

LO2 Prepare building information modelling data and construction information in support of a housing design proposition

LO3 Produce specifications and schedules, based on construction information, for a contract tender

LO4 Present a housing design proposal and tender package to a diverse audience, integrating information from other consultants.

Essential Content

LO1 Review a given site and client brief to develop a housing design proposition

Site considerations

Scale

Location

Traffic/access

Zoning/planning

Design considerations

Site/building orientation

Client/user requirements

Site density

Housing type/typology

Procurement model

Construction method

Health and safety

Building regulations

Environmental considerations

Materials

Energy supply

Heating/ventilation

Material transport

Construction/manufacturing method

Consultant integration

Information (e.g., structural, mechanical, cost)

Integration

Clash detection

Value engineering

Design revision

LO2 Prepare building information modelling data and construction information in support of a housing design proposition

Drawings

Presentation drawings

Technical drawings

Models

Physical models

Digital models

Building Information Modelling (BIM)

Consultant information

Structural drawings

Mechanical drawings

BIM

Cost information

Manufacturing information

LO3 Produce specifications and schedules, based on construction information, for a contract tender

Specification types

Outline specification

Performance specification

Prescriptive specification

Proprietary specifications

Schedules

Door schedules

Hardware schedules

Window schedules

Schedules of Work

Contracts

Contract type

Standard clauses and conditions

Contract prelims

LO4 **Present a housing design proposal and tender package to a diverse audience, integrating information from other consultants**

Proposal

Feasibility

Design

Engineering

Cost

Audience

Professional

Non-professional

Statutory bodies

Presentation

Format (e.g., written report, audio-visual, etc.)

Feedback and reflection

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Review a given site and client brief to develop a housing design proposition		
P1 Identify issues and considerations of site to inform a design proposition. **P2** Analyse a brief to develop a design proposition, responding to identified issues.	**M1** Assess the need for different consultants to support the development of a housing proposal.	**D1** Critically evaluate the influence of consultant information on a housing design proposition.
LO2 Prepare building information modelling data and construction information in support of a housing design proposition		
P3 Produce building information data for a housing design proposal. **P4** Prepare construction drawings and details in support of a housing design proposition.	**M2** Use building information modelling systems to coordinate information from consultants.	**D2** Evaluate the impact of consultants' information on the production of construction information, specifications and schedules.
LO3 Produce specifications and schedules, based on construction information, for a contract tender.		
P5 Produce specification information based on building information modelling data and construction information. **P6** Prepare relevant schedules for a contract tender.	**M3** Compile information required for a contract tender package for an appropriate form of contract.	
LO4 Present a housing design proposal and tender package to a diverse audience, integrating information from other consultants.		
P7 Present a coherent housing design proposal to a diverse audience. **P8** Integrate the information from consultants in support of a housing design and tender presentation.	**M4** Defend a design proposal in response to feedback and comment.	**D3** Reflect on feedback and comments to identify areas of good practice and areas for future improvement in a design proposal.

Recommended Resources

Print resources

BALLAST, D. (2009), *Architect's Handbook of Construction Detailing*, John Wiley & Sons

BUSSEY, P. (2019*), CDM 2015: A Practical Guide for Architects and Designers,* Routledge

CHING, F. (2011), *Building Construction Illustrated*, John Wiley & Sons

CHUDLEY, R., GREENO, R., KOVAC, K. (2020), *Chudley and Greeno's Building Construction Handbook*, Butterworth-Heinemann

CIBSE (2006), *Environmental Design*, CIBSE

CONSTRUCTION SPECIFICATIONS INSTITUTE (2011), *The CSI Construction Specifications Practice Guide*, John Wiley & Sons

HUTH, M. (2018), *Understanding Construction Drawings*, Cengage Learning

KALIN, M., WEYGANT, R., ROSEN, H., REGENER, J. (2010), *Construction Specifications Writing: Principles and Procedures*, John Wiley & Sons

LAWSON, B. (2006), *How Designers Think: The Design Process Demystified*, Routledge

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

MEIER, H., WYATT, D. (2008), *Construction Specifications*, Delmar Pub

Web resources

https://www.designingbuildings.co.uk	**Designing Buildings Wiki** (General Reference)
https://www.thenbs.com	**The NBS Knowledge** (General Reference)
https://www.csiresources.org	**Construction Specifier International** (General Reference)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 47: Advanced Building Information Modelling
- Unit 51: Advanced Construction Development & Prototyping.

Unit 53: Advanced Off-site Construction

Level: 5

Credits: 15

Ofqual Code: F/618/8130

Introduction

In this unit, students will explore different approaches to off-site construction. Focusing on the technical features of different methods of manufacturing and logistics, they will develop the knowledge and skills to be able to select appropriate forms of manufacture in support of specific design and delivery aims concerning building development and delivery. This includes modular construction, factory construction, automation and robotics, and 3D printing. Students will consider the ways in which off-site processes and technologies may influence building design and delivery.

By the end of this unit, students will be able to evaluate and select strategies for off-site production, to meet the technical and design challenges associated with the construction market.

Learning Outcomes

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

LO1 Explore different production models and their application to building manufacture

LO2 Analyse how the relationship between material selection and technical processes inform design decisions

LO3 Develop design and construction information to support a high-volume off-site building manufacture strategy to meet stakeholder requirements for a given building type and context

LO4 Present a strategy for high-volume off-site manufacture for a given building type and context.

Essential Content

LO1 **Explore different production models and their application to building manufacture**

Production model

Lean manufacturing

'Just-in-time' (JIT)

Automotive/assembly line

Mobile factory

Production challenges

Material sourcing

Factory/production facility

Logistics

On-site installation

Cost

LO2 **Analyse how the relationship between material selection and technical processes inform design decisions**

Material

Sustainability

Waste

Aesthetics

Supply

Transport

Technical process

Manufacturing

Manual assembly

Robotics

3D printing

Logistics (e.g., transport, assembly, storage, etc.)

Design impact

Speed of construction/delivery

Cost of construction/delivery

Addressing client/user needs

LO3 **Develop design and construction information to support a high-volume off-site building manufacture strategy to meet stakeholder requirements for a given building type and context**

Stakeholders

Client (e.g., private, developer, investors)

Institutions (e.g., government, private sector, housing association)

Users (e.g., building users, general public)

Manufacturer

Supplier

Context

Typology (e.g., building type, building use)

User requirements

Environment/site

Economy/market

Statutory regulations

Design aims

Selection criteria

Volume/demand

Production model

Logistics

Budget

Time/deadline

Market/economy

Sustainability

Procurement

User/stakeholder requirements

Strategy

Contextual features

Design response

Material strategy

Sustainability

Production model

Market opportunity

Manufacturing approach

Design information

Sketches

Models

Drawings

Renderings

Animations/walk-thrus

Construction information

General Arrangement Drawings (e.g., plans, sections, elevations)

Details

Consultant information (e.g., structural, mechanical, cost)

Schedules (e.g., door, window, finishes)

Specifications

LO4 **Present a strategy for high-volume off-site manufacture for a given building type and context**

Design proposition

Addressing client requirements

Meeting statutory requirements

Manufacturing strategy

Materials

Method of manufacture

Transport requirements

On-site installation requirements (e.g., equipment, services, health and safety requirements)

Cost information

Presentation

Mode (e.g., report, audio-visual, video, etc.)

Audience (e.g., professional, client/stakeholder, technical)

Feedback

Reflection

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore different production models and their application to building manufacture</td><td rowspan="4">D1 Critically analyse the way that production model and material selection support a high-volume off-site building manufacturing strategy that addresses sustainability issues.</td></tr>
<tr><td>P1 Discuss the features of different production models in manufacturing.

P2 Explain the challenges of different production models for building manufacture.</td><td>M1 Evaluate the potential benefits that a production model may address specific production challenges.</td></tr>
<tr><td colspan="2">LO2 Analyse how the relationship between material selection and technical processes inform design decisions</td></tr>
<tr><td>P3 Discuss the issues associated with material supply, sustainability, waste and material use in off-site manufacturing.

P4 Analyse the way in which technical processes inform and influence building design for manufacture.</td><td>M2 Assess the design impact of manufacturing and logistics on building delivery.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Develop design and construction information to support a high-volume off-site building manufacture strategy to meet stakeholder requirements for a given building type and context		
P5 Analyse a given context to determine factors that may inform selection of an off-site production model. **P6** Develop a strategy for high-volume off-site manufacture to address identified factors for a given context.	**M3** Compare approaches to off-site manufacture to support high-volume building manufacturing in a given context.	**D2** Critically evaluate a high-volume off-site manufacturing strategy in meeting the needs of stakeholders, technical challenges and sustainability.
LO4 Present a strategy for high-volume off-site manufacture for a given building type and context		
P7 Present a coherent strategy for high-volume off-site manufacture that meets client and stakeholder requirements. **P8** Discuss the regulatory and health and safety requirements related to off-site construction.	**M4** Justify a high-volume off-site manufacturing strategy through presentation of research and analysis.	

Recommended Resources

Print resources

COTTERELL, J., DADEBY, A. (2012), *The Passivhaus Handbook: A practical guide to constructing and retrofitting buildings for ultra-low energy performance*, Green Books

DUFFY, A., ROGERS, M., AYOMPE, L. (2015*), Renewable Energy and Energy Efficiency*, John Wiley & Sons

EMMITT, S. (2018), *Barry's Advanced Construction of Buildings*, John Wiley & Sons

GRINNELL, S. (2015), *Renewable Energy & Sustainable Design*, Cengage Learning

GOULDING, J., RAHIMIAN, F. (2019), *Offsite Production and Manufacturing for Innovative Construction*, Routledge

HICKEY, T. (2014), *Construction Technology: Designing Sustainable Homes*, Gill Education

LAWSON, M., OGDEN, R., GOODIER, C. (2014), *Design in Modular Construction*, CRC Press

SAWHNEY, A., RILEY, M., IRIZARRY, J. (2020), *Construction 4.0: An Innovation Platform for the Built Environment*, Routledge

SINOPOLI, J. (2009), *Smart Buildings Systems for Architects, Owners and Builders*, Butterworth-Heinemann

SMITH, R., QUALE, J. (2017), *Offsite Architecture*, Routledge

STIRLING, C. (2003), *Off-site Construction: An Introduction*, BRE

Web resources

https://www.buildoffsite.com	**Build Offsite** (General Reference)
https://www.trada.co.uk	**The Timber Research and Development Association** (Professional Body)
https://www.lboro.ac.uk	**Offsite Construction – Loughborough University** (General Reference)
https://www.renewableenergycentre.co.uk	**The Renewable Energy Centre** (General Reference)
https://www.icevirtuallibrary.com	**ICE Virtual Library** (General Reference)

https://www.brydenwood.co.uk	**Bryden Wood – What does DfMA stand for? A simple definition framework for DfMA and MMC** (Article)
https://www.brydenwood.co.uk	**Bryden Wood – Delivery Platforms for Government Assets** (Report)
https://www.brydenwood.co.uk	**Bryden Wood – Platforms: Bridging the gap between construction + manufacturing** (Report)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 15: Principles of Alternative Energy
- Unit 23: Construction Economics & Sustainability
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 35: Sustainable Methods of Construction
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling
- Unit 51: Advanced Construction Development & Prototyping
- Unit 52: Advanced Housing Design & Specification.

Unit 54: Advanced Quantity Surveying Practice

Level: 5

Credits: 15

Ofqual Code: J/618/8131

Introduction

The function of a quantity surveyor on a large project will take several forms. The professional quantity surveyor (PQS) will support the client in terms of the project's budget and obtaining tenders that are within this budget. Contract selection will be a function to enable legally binding agreements between the client and the main contractor. The PQS will advise a client as to which is the best contract to use for their project. The main contractor's quantity surveyor's function on a large project will be to assemble a quantity surveying team that can control the costs of the works in accordance with the tender sum submitted. They will also maximise the revenue potential against any variations, buying or construction processes to maximise the project's return.

The quantity surveyor interacts with many different roles in project teams. They may work alongside the architect or designer, costing project elements and specifying, to arrive at a budget for the client. The main contractor's quantity surveyor interacts with the estimating and construction teams. They work to establish what the estimator has included in terms of prices from suppliers and subcontractors so that orders can be placed in advance of the work commencing. Once the project has begun, they are involved in ensuring that the costs of the project are controlled to ensure they remain within the agreed contract sum.

In this unit, students will expand their knowledge and understanding of quantity surveying practice, with the emphasis on more complex projects and contract requirements.

Learning Outcomes

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

LO1 Analyse the functions of a quantity surveyor on large complex projects

LO2 Explain the quantity surveyor's interactions with project teams

LO3 Prepare a contract for a complex project

LO4 Develop preliminary items and specification sections for a building or infrastructure project.

Essential Content

LO1 Analyse the functions of a quantity surveyor on large complex projects

Pre-contract: professional quantity surveyor

Costing of client's project into a budget

Advising client on potential procurement routes

Advising client on contract types

Preparation of any nominated or named contractors

Obtaining quotations for nominated works

Preparation of bills of quantity (BoQ)

Preparation of tender documentation

Specifications

Select tender list compiled

Sending out project enquiries

Receiving tenders

Adjudicating tenders

Awarding project

Pre-contract: main contractor's quantity surveyor

Advising on procurement process and contract

Read and digest tender documentation

Analysis of project into packages

Obtaining quotations for packages of work

Materials and plant enquiries

Assembly of tender documentation

Specifications

Costing of preliminary items

Tender adjudication meeting

Tender submission

Negotiation with specialist subcontractors

Construction phase: professional quantity surveyor

Issue and sign contracts

Pre-start meeting

Check valuations

Negotiations with main contractor

Issue certificates

Costing and agreement on variations

Running final account summary

Agree final account

Release retention

Construction phase: main contractor's quantity surveyor

Legal and regulatory requirements for quantity surveyors

Contract law

Health and safety Regulations

Professional body codes of conduct and codes of practice

Financial regulations and financial regulators

LO2 **Explain the quantity surveyor's interactions with project teams**

Main contractor's quantity surveyor

Interaction with PQS and client regarding signing contract documentation

Pre-start meeting

Liaising with the estimator regarding quotations used in tender

Discussions with contracts manager and site manager regarding programme

Interaction with other quantity surveyors (QS) in the project team

Interaction with buying department for materials and plant requisitions

Interim valuations interactions with site manager and PQS

Interactions with site manager regarding variations

Attendance at site progress meetings

Interactions and negotiations with nominated and domestic subcontractors

Interactions with contracts manager regarding delays and extensions

Handover meetings

Professional quantity surveyor

Tender adjudication and interviews with main contractor's estimating team

Award of contract with client

Award of contract to main contractor

Cost value engineering with main contractor

Issue and obtain contract signatures between client and main contractor

Control client's budget with main contractors QS

Liaise regarding additional works and final account summary

Attend site progress and budget meetings

Interaction and negotiation with main contractor

Advise client on spending against budget

Attend handover meetings

Interact on final account and retention release

Dealing with disputes between parties

Avoiding and managing conflicts

Recording issues and complaints

Legal processes (e.g., adjudication, arbitration)

Financial disputes (e.g., cost overruns, valuation disputes)

LO3 **Prepare a contract for a complex project**

Contract selection criteria

Type of construction work

Duration of project

Number of projects

Value of work

Flexibility required

Private or public sector

Size of project

Funding strategy

Construction contracts

Joint Contracts Tribunal (JCT) (e.g., standard building contract, intermediate form of building contract, major project construction contract, design and build contract, management building contract, construction management contract, constructing excellence contract, measured term contract, prime cost building contract)

FIDIC (Fédération Internationale des Ingénieurs-Conseils)

NEC (The New Engineering Contract): Engineering and construction contract

CIOB (The Chartered Institute of Building) (e.g., CPC 2013 – CIOB Contract for use with Complex Projects)

Local international contract agreements

Classification of contracts (e.g., lump sum contracts, unit price contracts, cost-plus contracts, target cost contract)

LO4 **Develop preliminary items and specification sections for a building or infrastructure project**

Project information

Client's complex brief with working drawings

Specification of elements making up project

Cost estimate for the project

Client's initial budget

Specifications

Types of specification (e.g., performance specifications, prescriptive specifications)

Standard forms (e.g., construction, civil engineering, building services)

Specification sections and classifications

Preliminary items

Specific 'prelims' sector requirements (e.g., construction, civil engineering, building services, relation to contract)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse the functions of a quantity surveyor on large complex projects		
P1 Analyse the pre-construction and construction functions of a professional quantity surveyor and a contractor's quantity surveyor. **P2** Discuss the legal and regulatory responsibilities of a quantity surveyor during different phases of a project.	**M1** Compare the functions of a professional quantity surveyor and a contractor's quantity surveyor during the execution of construction contract for a complex project.	**D1** Critically analyse the contractor's quantity surveyor's interactions in maintaining the profitability of a contract.
LO2 Explain the quantity surveyor's interactions with project teams		
P3 Discuss the interaction of a professional quantity surveyor and a contractor's quantity surveyor with different teams during the pre-construction phase of a project. **P4** Describe the process of valuation and release of payments by the quantity surveyor during the construction phase.	**M2** Analyse the financial interactions between the professional quantity surveyor and the contractor's quantity surveyor during the construction phase.	

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO3 Prepare a contract for a complex project</td><td rowspan="4">D2 Justify the selection of a contract, prelims and specification sections in meeting the needs of client and contractor for a large complex project.</td></tr>
<tr><td>P5 Analyse the criteria used for the selection of a contract for a large complex project.

P6 Prepare a contract, based on an appropriate standard, for a large complex project.</td><td>M3 Assess the selection of a contract in meeting the requirements for a given project.</td></tr>
<tr><td colspan="2">LO4 Develop preliminary items and specification sections for a building or infrastructure project</td></tr>
<tr><td>P7 Prepare preliminary items for a building or infrastructure project specification, based on an appropriate standard.

P8 Develop specification sections to define works for building or infrastructure project, based on an appropriate standard.</td><td>M4 Evaluate the relationship between preliminary items and specification sections in clearly defining works.</td></tr>
</table>

Recommended Resources

Print resources

ASHWORTH, A., HOGG, K., HIGGS, C. (2013), *Willis's Practice and Procedure for the Quantity Surveyor*, John Wiley & Sons

CARTLIDGE, D. (2019), *Estimator's Pocket Book Second Edition*, Routledge

CARTLIDGE, D. (2017), *New Aspects of Quantity Surveying Practice*, Routledge

COOPER, R. (2017), *Target Costing and Value Engineering*, Routledge

TOWEY, D. (2017), *Construction Quantity Surveying*, John Wiley & Sons

Web resources

https://www.cices.org	**Chartered Institution of Civil Engineering Surveyors** (Professional Body)
https://www.designingbuildings.co.uk	**Designing Buildings Wiki** (General Reference)
https://www.rics.org	**Royal Institution of Chartered Surveyors** (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 44: Maintenance & Operations
- Unit 47: Advanced Building Information Modelling.

Unit 55: Alternative Sustainable Solutions in Construction

Level: 4

Credits: 30

Ofqual Code: J/650/4844

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:

LO1 Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies

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

LO3 Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation

LO4 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, modulisation/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

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies</td><td rowspan="4">LO1 and LO2

D1 Evaluate the factors that inform the selection of a retrofit project.</td></tr>
<tr><td>P1 Describe the principals of modern sustainability theory.

P2 Explain the market forces that dictate energy supply and demand.</td><td>M1 Analyse the impact of socio-economic factors that influence a retrofit project.</td></tr>
<tr><td colspan="2">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</td></tr>
<tr><td>P3 Compare Modern Methods of Construction (MCC).

P4 Describe the available alternative methods of power generation.</td><td>M2 Analyse the selection of MMC in terms of alternative methods of power generation.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation		**LO3**
P5 Select appropriate solutions for a given retrofit project. **P6** Produce data to draw valid and meaningful conclusions and recommendations from data analysis. **P7** Calculate the impact of a retrofit project.	**M3** Justify solution decisions based on design, funding, sustainability and performance.	**D2** Evaluate the selection outcomes of a retrofit proposal in relation to a specific installation.
LO4 Present the retrofit solution for the given building and evaluate the solution and presentation		**LO4**
P8 Present the recommended retrofit solution using an appropriate format. **P9** Explain possible communication strategies and presentation methods that could be used to inform the recipient of the recommended retrofit solution. **P10** Review feedback given and own performance.	**M4** Reflect on the effectiveness of the chosen communication strategy in presenting the retrofit solution.	**D3** Appraise own performance in managing the retrofit project, draw conclusions and make recommendations that would improve performance in the future.

Recommended Resources

Print resources

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.

Web resources

bregroup.com	**BREEAM Assessment Methods and Standards** (General Reference)
building.co.uk	**Construction articles and papers** (General Reference)
constructionnews.co.uk	***Construction News* 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 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 9: Principals of Heating, Ventilation and Air Conditioning
- Unit 13: Building Information Modelling
- Unit 16: Principles of Alternative Energy
- Unit 23: Construction Economics & Sustainability
- Unit 24 Principles of Off-site Construction
- Unit 35: Sustainable Methods of Construction.

April 2025

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