Syllabus

Civil Engineering

Year 1 & Year 2

Kings Cornerstone International College

Unit 1: Individual Project (Pearson-set)

Unit code	**R/615/1387**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

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

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

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

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

Learning Outcomes

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

1 Formulate a project that will provide a solution to an identified problem

2 Manage a project within agreed timescales and specification; documenting the process throughout

3 Evaluate potential project management solutions

4 Produce a project report and deliver a presentation of the final project outcomes.

Essential Content

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

Project identification

Research methods

Feasibility studies

Brief and specification

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

Resources and resource planning

Costs and cost planning

Work plan:

Gantt charts

Project Evaluation and Review Technique (PERT) charts

Critical Path Method (CPM).

Project tracking:

Progress tracking

Milestones.

LO3 **Evaluate potential project management solutions**

PERT analysis

CPM analysis

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

Report formats

Presentation techniques.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Formulate a project that will provide a solution to an identified problem</td><td rowspan="5">LO1 and LO2

D1 Evaluate the relationship between project identification, feasibility and project planning, with consideration of the impact of project scope on time and resources</td></tr>
<tr><td>P1 Select an appropriate construction-based project, giving reasons for your choice

P2 Identify the main components of a project specification</td><td>M1 Explain why the project specification is of fundamental importance to a successful project outcome</td></tr>
<tr><td colspan="2">LO2 Manage a project within agreed timescales and specification, documenting the process throughout</td></tr>
<tr><td>P3 Identify potential resources, costs and timescales

P4 Describe a range of appropriate techniques for generating realistic potential solutions</td><td>M2 Prepare and update a project management plan, using standard systems of time and resource tracking</td></tr>
</table>

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO3 Evaluate potential project management solutions</td><td rowspan="5">LO3 and LO4

D2 Appraise your own performance in managing the project; draw conclusions and make recommendations that would further improve your performance in the future</td></tr>
<tr><td>P5 Explore project management strategies to determine suitability for a given project

P6 Justify the selection of your preferred solution, making reference to your initial project specification</td><td>M3 Compare the outcomes of your initial planned resources, timescales and costs against actual outcomes</td></tr>
<tr><td colspan="2">LO4 Produce a project report and deliver a presentation of the final project outcomes</td></tr>
<tr><td>P7 Produce a written report identifying each stage of the project

P8 Utilise appropriate forms of referencing and citation in the preparation of a written report

P9 Prepare a presentation of your final project outcomes, utilising industry standard software</td><td>M4 Present your final project outcomes and recommendations to a selected audience</td></tr>
</table>

Recommended Resources

Textbooks

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

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

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

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

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

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

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

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

Unit 2: Construction Technology

Unit code	**Y/615/1388**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

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

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

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

Learning Outcomes

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

1 Explain the terminology used in construction technology

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

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

4 Illustrate the supply and distribution of a range of building services and how they are accommodated within the building.

Essential Content

LO1 **Explain the terminology used in construction technology**

Types of construction activity:

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

Construction technology terminology:

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

Construction information:

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

Sustainability:

Supply chain

Lifecycle

'Cradle-to-grave'

'Cradle-to-cradle'

Circular economies.

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

Pre-design studies:

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

Substructure functions and design considerations:

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

Types of foundations:

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

Types of superstructure:

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

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

Walls:

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

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

Roofs:

Pitched and flat roof systems, roof coverings.

Floors:

Ground floors, intermediate floors, floor finishes.

Staircases:

Timber, concrete, metal staircases, means of escape.

Finishes:

Ceiling, wall and floor finishes.

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

Site remediation and de-watering:

Contamination management: cut-off techniques, encapsulation.

Soil remediation: stone piling, vibro-compaction.

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

Substructure works:

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

Superstructure works:

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

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

Primary service supply

Cold water

Gas

Electricity.

Services distribution

Hot and cold water

Single-phase and 3-phase electricity

Air conditioning ductwork.

Services accommodation:

Raised access flooring

Suspended ceilings

Partitioning

Rising ducts.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explain the terminology used in construction technology</td><td rowspan="3">D1 Evaluate how the functional characteristics and design selection criteria impact on the eventual design solution</td></tr>
<tr><td>P1 Describe the differences between residential, commercial and industrial buildings
P2 Explain how the functional characteristics and design selection criteria are informed by proposed building use
P3 Discuss the ways in which sustainability can be promoted in building projects</td><td>M1 Apply the terminology used in construction technology to a given building construction project</td></tr>
<tr><td colspan="2">LO2 Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria</td></tr>
<tr><td>P4 Describe the pre-design studies carried out and types of information collected for a given construction site
P5 Explain the functional characteristics and design criteria for primary and secondary elements of a building substructure and superstructure</td><td>M2 Analyse how site conditions impact on the design of foundations
M3 Illustrate how the component parts of an element allow it to fulfil its function</td><td rowspan="4">LO2 and LO3
D2 Prepare a design report identifying superstructure, substructure and civil engineering structures necessary for a given building construction project</td></tr>
<tr><td colspan="2">LO3 Identify the different types of civil engineering/infrastructure technology used in support of buildings</td></tr>
<tr><td>P6 Describe techniques used for remediating the site prior to construction commencing
P7 Describe the types of substructure works carried out by civil engineers</td><td>M4 Compare different types of structural frame used to carry the primary and secondary elements of the superstructure</td></tr>
</table>

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

Recommended Resources

Textbooks

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

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

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

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

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

Unit 3: Science & Materials

Unit code	**D/615/1389**
Unit type	**Core**
Credit value	**15**

Introduction

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

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

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

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

Learning Outcomes

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

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

2 Discuss the environmental and sustainability factors which can impact on and influence the material choices for a construction project

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

4 Evaluate the performance of a given building in respect of its human comfort requirements.

Essential Content

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

Regulations and guidance:

Health & safety management regulations

Design management regulations

Provision and use of equipment regulations

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

Materials handling and installation:

Risk assessments and method statements (qualitative and quantitative)

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

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

Personal Protective Equipment (PPE).

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

Environmental considerations:

Lifecycle assessment

Environmental profile methodology

Environmental product declaration and certification

Embodied energy

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

Sustainability:

Resource availability and depletion: renewable and non-renewable materials

Reuse and recycling of construction and demolition waste

Waste and Resources Action Programme (WRAP).

Environmental assessment methods:

Building Research Establishment Environmental Assessment Method (BREEAM)

Leadership in Energy and Environmental Design (LEED)

Green Star

Estidama, or other forms of environmental assessment

Construction Industry Research Information Association.

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

Material testing:

Testing methods, interpreting test data

Codes and standards.

Structural behaviours

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

Inherent material properties.

Relationship between material properties, behaviour and use

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

Human comfort provision:

Indoor environmental quality: thermal, illumination, sound, ventilation

Thermal losses and gains

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

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Review health & safety regulations and legislation associated with the storage, handling and use of materials on a construction site		
P1 Explain how regulations impact on the use, storage and handling of a selection of vocationally typical construction materials	**M1** Assess how risk assessments can be used to address significant hazards posed by selected materials or activities	**D1** Discuss how multiple regulations and legislation would apply to a given site activity, highlighting how to plan and manage for safe handling and use

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO2 Discuss the environmental and sustainability factors which impact on and influence the material choices for a construction project</td><td rowspan="5">LO2 and LO3

D2 Illustrate how the use of sustainable practices and considerations for material choice can improve the environmental rating of the completed building</td></tr>
<tr><td>P2 Explain material environmental profiling and lifecycle assessment Use a relevant material to exemplify your explanation

P3 Discuss the benefits of product declaration and environmental certification</td><td>M2 Produce a waste management plan for a given project, taking into account a typical range of relevant waste materials</td></tr>
<tr><td colspan="2">LO3 Present material choices for a given building using performance properties, experimental data, sustainability and environmental consideration</td></tr>
<tr><td>P4 Present the results of relevant testing procedures to identify performance characteristics of selected construction materials

P5 Discuss the results in terms of the material properties and regulatory requirements, highlighting any unexpected results and why these may occur

P6 Select construction materials for a given building based upon their performance properties in use</td><td>M3 Assess the effects of loading structural materials and compare the behaviours and performance of materials which could be used for the same function</td></tr>
</table>

Pass	Merit	Distinction
LO4 Evaluate the performance of a given building 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 building and explain how these contribute to a balanced indoor environment	**M4** Perform calculations which relate to a selected area (lux levels, u-values, acoustic and ventilation)	**D3** Evaluate how the use of passive or active strategies can minimise energy, materials, water, and land use

Recommended Resources

Textbooks

BLANC, A. (2014) *Internal Components*. Abingdon: Routledge.

BUXTON, P. (2015) *Metric Handbook: Planning and Design Data*. Abingdon: Routledge.

CASINI, M. (2016) *Smart Buildings: Advanced Materials and Nanotechnology to Improve Energy*. Duxford: Woodhead Publishing.

CLAISSE, P.A. (2015) *Civil Engineering Materials*. Kidlington: Butterworth-Heinemann.

DEAN, Y. (1996) *Materials Technology* (Mitchells Building Series). Abingdon: Routledge.

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

EVERETT, A. (1994) *Materials. (Mitchells Building Series)*. 5th ed. Abingdon: Routledge.

KATIB, J.M. (2009) *Sustainability of Construction Materials*. Abingdon: Woodhead Publishing Ltd.

LYONS, A. (2014) *Materials for Architects and Builders*. 5th ed. Abingdon: Routledge.

PACHECO-TORGA, F. and JALALI, S. (2011) *Eco-Efficient Construction and Building Materials*. London: Springer.

PACHECO-TORGA, F. et al. (2013) *Eco-efficient Construction and Building Materials, Life Cycle Assessment (LCA), Eco-Labelling and Case Studies.* London: Springer.

THOMAS, R. (ed.) (2006) *Environmental design: An Introduction for Architects and Engineers*. 3rd ed. London: Taylor & Francis.

Links

This unit links to the following related units:

Unit 2: Construction Technology

Unit 9: Principles of Heating Services Design & Installation

Unit 15: Principles of Refurbishment

Unit 16: Principles of Alternative Energy

Unit 35: Alternative Methods of Construction

Unit 46: Advanced Materials

Unit 4: Construction Practice & Management

Unit code	**R/615/1390**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

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

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

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

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

Learning Outcomes

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

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

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

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

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

Essential Content

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

Understanding of the construction industry:

Historical development of the construction industry

Professional and other institutes, including societies

Links between professional, technical and skills professionals

Contractor and head office structure

Site structure and organisation

Types of contractual work tendered by companies.

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

Company types:

Professional relationships between companies

Contract tendering

Tender process.

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

Master programmes and contract planning techniques

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

Modern procurement methods within construction

Sustainability

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

Key stakeholders in the construction process

BIM and collaboration

Health & safety within the construction industry:

Pre-construction regulations and legislation

Site safety.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Describe the construction industry with reference to company structures and other activities</td><td rowspan="3">D1 Critically evaluate how construction companies have developed their structure and business ethos</td></tr>
<tr><td>P1 Explain how the construction industry has developed and encompassed professionalism within its structures

P2 Demonstrate the scope and linkage between all parties within a construction organisation

P3 Identify the type of contractual work tendered by contractors</td><td>M1 Analyse how the construction industry has developed overall in terms of company structures, it's employees and contracted work</td></tr>
<tr><td colspan="2">LO2 Explain different types of construction companies within the market and their relationships within the tendering process</td></tr>
<tr><td>P4 Identify the different types of construction companies in the market

P5 Explain the relationship between different construction organisations</td><td>M2 Analyse the Analyse the relationships between construction companies through contracts and tendering.</td><td>D2 Compare the factors that influence contract relationships between different organisations involved in tendering.</td></tr>
</table>

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

Recommended Resources

Textbooks

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

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

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

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

Websites

www.ciob.org.uk	Chartered Institute of Building (General Reference)
www.rics.org	Royal Institute of Chartered Surveyors (General Reference)

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

Unit code	**D/615/1392**
Unit level	**4**
Credit value	**15**

Introduction

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

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

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

Learning Outcomes

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

1 Evaluate different types of construction information in the context of diverse project types

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

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

4 Assess ways in which construction professionals collaborate in the production of construction information.

Essential Content

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

Construction drawings

Site plans

Floor plans, roof plans, ceiling plans

General arrangement

Elevations

Assembly drawings

Component drawings/details

Schedules

Door schedules

Window schedules

Hardware schedules

Specifications

Performance specification

Outline specification

Full specification

Specification templates/standards

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

Computer Aided Design (CAD)

Templates

Title blocks

Annotation

Building Information Modelling (BIM)

Specification software

Bills of quantities

Schedules of works

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

Reading construction drawings

Information co-ordination

Clash detection

'Red-lining'

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

Project roles

Information production

Hierarchy of roles and information

Project collaboration

Document sharing/distribution

Online/cloud-based collaboration

Building Information Modelling (BIM).

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Evaluate different types of construction information in the context of diverse project types</td><td rowspan="5">LO1 and LO2

D1 Justify the use of specific types of construction information in support of a given project</td></tr>
<tr><td>P1 Explain the use of construction information in the context of a project

P2 Describe the different types of construction information and their uses</td><td>M1 Compare different types of construction information to identify their suitability in specific contexts.</td></tr>
<tr><td colspan="2">LO2 Develop construction drawings, details, schedules and specifications in support of a given construction project</td></tr>
<tr><td>P3 Develop a set of general arrangement drawings, selected details and door/window schedules

P4 Produce an outline bill of quantities</td><td>M2 Compose a schedule of works</td></tr>
</table>

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO3 Interpret different types of construction information in order to explain a construction project</td><td rowspan="5">LO3 and LO4

D2 Propose corrections to construction drawings and specifications using industry standard forms of notation</td></tr>
<tr><td>P5 Relate a set of construction drawings to a specification

P6 Evaluate construction drawings and details to identify 'clashes'</td><td>M3 Critique a body of construction information, identifying errors and discrepancies</td></tr>
<tr><td colspan="2">LO4 Assess ways in which construction professionals collaborate in the production of construction information.</td></tr>
<tr><td>P7 Assess the types of information produced by different participants in a construction project

P8 Examine the relationship between different bodies of information and how they work in conjunction</td><td>M4 Compare the roles of CAD and BIM in the collaborative production of construction information</td></tr>
</table>

Recommended Resources

Textbooks

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

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

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

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

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

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

Websites

www.designingbuildings.co.uk	Designing Buildings Wiki (General Reference)
www.thenbs.com	The NBS Knowledge (General Reference)
www.csinet.org	CSI (General Reference)

Links

This unit links to the following related units:

Unit 1: Individual Project

Unit 14: Building Information Modelling

Unit 26: Advanced Construction Drawing & Detailing

Unit 36: Advanced Building Information Modelling

Unit 22: Group Project (Pearson-set)

Unit code	**D/615/1408**
Unit type	**Core**
Unit level	**5**
Credit value	**15**

Introduction

While working in a team is an important skill in construction projects, collaboration goes beyond just teamwork. The success of a project relies not only on the ability of each person in a team to do their work, but on each individual's awareness of how their work relates to the work of others, how to ensure that information is shared effectively and that roles and responsibilities are clear.

Through this collaborative project-based unit, students will explore how to define roles within a collaborative team, recognising the skills (and 'skills gaps') of each member of the group. Together students will work to develop a construction project; based on their research and analysis, in response to the Pearson-set 'theme'.

Content in this unit will typically include role identification and allocation, collaborative structures, human resources management, project management, procurement, tender documentation, information/data sharing, meetings, Health & Safety, project costing and Building Information Modelling.

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

Learning Outcomes

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

1 Assess individual and group skills in order to allocate roles within a collaborative team

2 Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling

3 Prepare tender documentation; undertaking work appropriate to a defined role within a team

4 Evaluate own work, and the work of others, in a collaborative team.

Essential content

LO1 **Assess individual and group skills in order to allocate roles within a collaborative team**

Roles and responsibilities:

Skills auditing

Belbin Team Inventory

Myers Briggs Personality Type Indicator.

Human resources management:

Core job dimensions (skill variety, task identity, task significance, autonomy, feedback)

Job design (job rotation, job enlargement, etc.).

LO2 **Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling**

Project planning:

Setting goals

Defining 'deliverables'

Task definition

Identifying risks/risk management

Communications planning.

Resource management:

Human resources

Physical resources

Supply chain

Waste management.

Project scheduling:

Scheduling tools

Milestones

Blocks.

LO3 **Prepare tender documentation; undertaking work appropriate to a defined role within a team**

Tender documentation:

Construction drawings

Specifications

Schedules of work

Cost plan

Health & safety legislation

Building Information Modelling.

LO4 **Evaluate own work, and the work of others, in a collaborative team**

Reflective practice:

Schön's 'The Reflective Practitioner'

Gibbs' 'Reflective Cycle'

Reflection vs Description.

Reflection in practice:

Project lifecycle

Post implementation review.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Assess individual and group skills in order 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		**LO2 and LO3** **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 in order 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 & Safety method statement	**M3** Evaluate the ways in which Building Information Modelling 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 their own work, recording this throughout the project **P9** Evaluate their own working practices in relation to that of other members of the team, identifying areas of good practice	**M4** Evaluate their own personality profile in relation to your 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

Textbooks

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

BELBIN, M. (2010) *Team Roles at Work*. London: Taylor & Francis.

BENNETT, J. and PEACE, S. (2006) *Partnering in Construction: A Code of Practice for Strategic Collaborative Working.* Abingdon: Butterworth-Heinemann.

BOUCHLAGHEM, D. (2011) *Collaborative Working in Construction.* London: Spon Press.

CIOB (2010) *Guide to Good Practice in the Management of Time in Complex Projects.* 3rd ed. Chichester, West Sussex: John Wiley & Sons.

DAINTY, A. and LOOSEMORE, M. (ed.) (2012) *Human Resource Management in Construction: Critical Perspectives.* Abingdon: Routledge.

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

MYERS, S. and CHILDS, R. (2016) *Understanding Team Roles.* London: Nielson Book Services Limited.

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

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

Unit 28: Further Mathematics for Construction

Unit code	**M/615/1414**
Unit level	**5**
Credit value	**15**

Introduction

The understanding of more advanced mathematics is important within the civil engineering and building services engineering industries. Students must be introduced to additional topics that will be relevant to them as they progress to the next level of their studies; advancing their knowledge of mathematical theory gained in the Level 4 Unit 8: Mathematics for Construction.

The aim of this unit is to teach students to analyse and model civil engineering or building services engineering situations using mathematical techniques.

Among the topics included in this unit are: number theory, complex numbers, matrix theory, linear equations, numerical integration, numerical differentiation, and graphical representations of curves for estimation within an engineering context. Finally, students will expand their knowledge of calculus to discover how to model and solve problems using first and second order differential equations.

On successful completion of this unit students will be able to use applications of number theory in practical construction situations, solve systems of linear equations relevant to construction applications using matrix methods, approximate solutions of contextualised examples with graphical and numerical methods, and review models of construction systems using ordinary differential equations. As a result they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

1 Apply instances of number theory in practical construction situations

2 Solve systems of linear equations relevant to construction applications using matrix methods

3 Approximate solutions of contextualised examples with graphical and numerical methods

4 Review models of construction systems using ordinary differential equations.

Essential Content

LO1 **Apply instances of number theory in practical construction situations**

Number theory:

Bases of a number (Denary, Binary, Octal, Duodecimal, Hexadecimal) and converting between bases

Types of numbers (Natural, Integer, Rational, Real, Complex)

The modulus, argument and conjugate of complex numbers

Polar and exponential form of complex numbers

The use of de Moivre's Theorem in engineering

Complex number applications e.g. electric circuit analysis, information and energy control systems.

LO2 **Solve systems of linear equations relevant to construction applications using matrix methods**

Matrix methods:

Introduction to matrices and matrix notation

The process for addition, subtraction and multiplication of matrices

Introducing the determinant of a matrix and calculating the determinant for a 2x2 matrix

Using the inverse of a square matrix to solve linear equations

Gaussian elimination to solve systems of linear equations (up to 3x3).

LO3 **Approximate solutions of contextualised examples with graphical and numerical methods**

Graphical and numerical methods:

Standard curves of common functions, including quadratic, cubic, logarithm and exponential curve

Systematic curve sketching knowing the equation of the curve

Using sketches to approximate solutions of equations

Numerical analysis using the bisection method and the Newton–Raphson method

Numerical integration using mid-ordinate rule, the trapezium rule and Simpson's rule.

LO4 **Review models of construction systems using ordinary differential equations**

Differential equations:

Formation and solutions of first-order differential equations

Applications of first-order differential equations e.g. RC and RL electric circuits, Newton's laws of cooling, charge and discharge of electrical capacitors, and complex stresses and strains

Formation and solutions of second-order differential equations

Applications of second-order differential equations e.g. mass-spring-damper systems, information and energy control systems, heat transfer, automatic control systems and beam theory and RLC circuits

Introduction to Laplace transforms for solving linear ordinary differential equations

Applications involving Laplace transforms, such as electric circuit theory, load frequency control, harmonic vibrations of beams and engine governors.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
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 3x3 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

Pass	Merit	Distinction
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
LO4 Review models of construction systems using ordinary differential equations		
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	**D4** Evaluate first- and second-order differential equations when generating the solutions to construction problems

Recommended resources

Textbooks

BIRD, J. (2014) *Higher Engineering Mathematics*. 7th ed. London: Routledge.

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

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

Websites

www.mathcentre.ac.uk	MathCentre (General Reference)
www.mathtutor.ac.uk	MathTutor (General Reference)

Unit 29: Geotechnics & Soil Mechanics

Unit code	**T/615/1415**
Unit level	**5**
Credit value	**15**

Introduction

This unit explores the essential relationship between civil engineering and the Earth's crust, in the support of built structures and highways. The ability to understand, evaluate and develop solutions, related to soil and rock, is a key aspect of civil and structural engineering.

Topics included in this unit are: rock types, soil description and classification, methods and techniques used when undertaking site investigations and laboratory testing, determination of soil properties and the importance of these geotechnical procedures and resultant findings to civil engineers.

On successful completion of this unit students will be able to analyse and evaluate modern geotechnical methods and apply these skills and knowledge to the initial design of infrastructure.

Learning Outcomes

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

1 Review rock types, their formation and uses within civil engineering

2 Explore and classify soils to current codes of practice

3 Analyse soil properties determined by geotechnical procedures

4 Produce a proposal to address identified geotechnical weaknesses and problems.

Essential Content

LO1 Review rock types, their formation and uses within civil engineering

Rock type formation and classification

Rock type susceptibility to weathering and weathering processes

Discontinuous nature of rock mass, folding and faulting

The use of rock within civil engineering

The use of uncemented sediments within civil engineering

LO2 Describe and classify soils to current codes of practice

Ground and site investigation

Soil sampling

Soil types

Soil description

Soil classifications

Soil particle size

Soil specific gravity

Soil plasticity index

LO3 Analyse soil properties determined by geotechnical procedures

Shear strength

Compressibility

Moisture content

Soil density

Specific gravity

Liquid and plasticity indices

California bearing ratio

LO4 Produce a proposal to address identified geotechnical weaknesses andproblems

Shear strength and embankment design

Compressibility and foundation design

Liquid and plasticity indices and foundation design

California bearing ratio and highway design.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate rock types, their formation and uses within civilengineering		
P1 Discuss rock type formation and classification, susceptibility to weathering and the weathering processes **P2** Analyse the discontinuous nature of rock mass	**M1** Evaluate the use of rock and uncemented sediments within civil engineering	**D1** Critically analyse example that address problems caused by the discontinuous nature of rock mass when tunnelling and constructing bridges, using case studies as examples
LO2 Explore and classify soils to current codes of practice		
P3 Explore methods and techniques used in ground and site investigation, soil sampling, soil descriptions and soil classifications to current codes of practice **P4** Explore how soils are classified from soil particle size, soil types, specific gravity and plasticity indices to current codes of practice	**M2** Evaluate 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

Pass	Merit	Distinction
LO3 Analyse soil properties determined by geotechnical procedures		**LO3 and LO4** **D3** Integrate test data to inform the development ofdesign proposals
P5 Evaluate how soil properties are determined, including moisture content, density, specific gravity, shear strength compressibility, liquid and plasticity indices, California bearing ratio	**M3** Analyse results from soil properties testing	
LO4 Produce a proposal to address identified geotechnical weaknesses and problems		
P6 Produce design proposals to address geotechnical problems related to embankments, bridge and road foundations for a given site	**M4** Justify the approach to a design proposal in meeting identified geotechnical weaknesses	

Recommended resources

Textbooks

CHUDLEY, R. and GREENO, R. (2012) *Advanced Construction Technology*. 5th ed.Harlow: Pearson.

CHUDLEY, R. and GREENO, R. (2014) *Building Construction Handbook*. 10th ed.Oxford: Butterworth-Heinemann.

MANLEY, S., CHARTERS, M., FRANCIS, C., TOPLISS, S. and DOYLE, M. (2008) *Construction*. Harlow: Pearson.

MCLEAN, A. and GRIBBLE, C. (1985) *Geology for Civil Engineers*. London: Routledge.

OSBOURN, D. and GREENO, R. (2007) *Introduction to Building*. 4th ed. Harlow: Pearson.

Websites

www.ciob.org.uk	Chartered Institute of Building(General Reference)
www.geology.com	Geology.com – Geology News and Information (General Reference)
www.ice.org.uk	Institution of Civil Engineers
www.thomastelford.com	Thomas Telford (General Reference)

Unit 30: Advanced Structural Design

Unit code	**A/615/1416**
Unit level	**5**
Credit value	**15**

Introduction

With the development of new materials and processes, along with technologies that allow us to design and model more complex structures, the demands on structural design become more complex. The ability to conceive of and accurately model complex buildings, bridges, roads and other types of structure, pushes both the aesthetic and technical envelope.

In managing the design and construction of modern structures, the civil or structural engineer must be able to carry out more complex calculations; dealing with dynamic conditions, while maintaining an awareness of the overall design intention.

Extending areas of study, from *Unit 20: Principles of Structural Design*, this unit will support students to extend their ability to design, test and quantify more complex structural conditions.

Learning Outcomes

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

1 Explore deflection due to wind loadings, on fixed structures, and strategies toresist wind loading

2 Determine bending, shear and deflection for complex support conditions

3 Design complex columns and piled foundations based on calculation

4 Explore the design of tensile structures.

Essential Content

LO1 Explore deflection due to wind loadings, on fixed structures, and strategiesto resist wind loading

Wind loading:

Calculating wind loading

Wind loading on tall buildings

Shear forces

Lateral load

Uplift load

Torsional load.

Managing wind loading:

Building form

Stiffening.

LO2 Determine bending, shear and deflection for complex support conditions

Bending:

Supported timber beams

Steel cantilever beams

Reinforced concrete cantilevers

Steel three-pin frames.

Shear:

Supported timber beams

Steel three-pin frames.

Deflection:

Supported timber beams with point loads and uniformly distributed loading

Steel cantilever beams with point loads and uniformly distributed loading

Reinforced concrete cantilever beams with point loads and uniformly distributed loading.

Structural connections:

Beam-to-beam connections

Beam-to-column connections

Types of connection

Bolt fixings

Welded connections

Fin plates

Splices

Bracing connections.

LO3 Design complex columns and piled foundations based on calculation

Axial loading:

Carrying capacity of timber columns

Carrying capacity of reinforced concrete piled foundations

Carrying capacity of steel piled foundations.

Eccentric loading:

Buckling

Stress.

Piled foundations:

End bearing piles

Friction piles

Sheet piles

Micropiling

Helical piles.

Structural design information:

CAD drawings

Building Information Modelling

Calculations.

LO4 Explore the design of tensile structures

Linear structures:

Suspension bridges

Cable-stayed beams/trusses.

Three-dimensional structures:

Tensegrity structures

Tensairity structures.

Surface-stressed structures:

Pre-stressed membranes

Gridshell

Fabric structure.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore deflection due to wind loadings, on fixedstructures, and strategies to resist wind loading		
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 **P5** Evaluate structural connections in relation to complex support conditions	**M2** Discuss the relationship between bending, shear and deflection	**D2** Critically evaluate different materials and theirstructural efficiency in managing bending, shear and deflection
LO3 Design complex columns and piled foundations basedon calculation		
P6 Calculate the axial load carrying capacity of complex columns, with eccentric loading **P7** Calculate the axial load carrying capacity of reinforced concrete piled foundations **P8** Prepare design information for a structure utilising piled foundations and steel columns	**M3** Discuss the benefits of using Building Information Modelling in the 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

Pass	Merit	Distinction
LO4 Explore the design of tensile structures		
P9 Discuss the differences between types of tensile structures **P10** Design a simple tensile structure for a given scenario	**M4** Compare tensile structural solutions to a given scenario	**D4** Using calculations as well as other research, justify the choice of a tensile structure solution for a given scenario

Recommended resources

Textbooks

ANTHONY, A. et al (2007) *Reynolds's Reinforced Concrete Designer's Handbook*. 11th ed. London: Taylor & Francis.

DURKA, F. et al (2002) *Structural Mechanics: Loads, Analysis, Design and Materials*. 6th ed. London: Prentice Hall.

FIONA, C. (2008) *Structural Engineer's Pocket Book*. 2nd ed. Oxford:Butterworth-Heinemann.

HULSE, R. and CAIN, J. (2000) *Structural Mechanics*. 2nd ed. Palgrave Macmillan.

MCKENZIE, W. (2003) *Design of Structural Elements*. London: Palgrave Macmillan.

MOSLEY, H. (2007) *Reinforced Concrete Design*. 6th ed. London: Palgrave.

OZELTON, E. (2006) *Timber Designers' Manual*. Chichester, West Sussex:Wiley-Blackwell.

SEWARD, D. (2003) *Understanding Structures: Analysis, Materials, Design*. 3rd ed. London: Palgrave Macmillan.

SMITH, P. (2001) *An Introduction to Structural Mechanics*. London: Palgrave Macmillan.

STEEL CONSTRUCTION INSTITUTE (2005) *Steel Design Manual*. 6th ed. Chichester, West Sussex: Wiley-Blackwell.

Electives

Unit 7: Surveying, Measuring & Setting-out

Unit code	**H/615/1393**
Unit level	**4**
Credit value	**15**

Introduction

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

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

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

Learning Outcomes

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

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

2 Explain the process of undertaking a topographic survey

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

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

Essential Content

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

Description of types of control points

Primary controls, first and second order

Secondary control

Different methods of marking control points

The use of local, national and grid control available

Conducting a closed traverse

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

Methods for checking accuracy of the traverse

Matching the control station accuracy to national standards or recommendations

Calculations to obtain corrected co-ordinates

LO2 Explain the process of undertaking a topographic survey

Purpose of a topographic survey

Links to initial control

Techniques to communicate a completed survey

Cut and fill information obtained from a survey

Methods of completing a topographic survey

Equipment to be used to capture topographic details

Use of free station and GPS to complete the survey

Coding systems for features to be surveyed

Data transfer techniques.

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

Examples of construction elements

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

Setting-out techniques

Holistic view of setting from the whole to the part

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

Techniques to obtain Setting-out data, including data transfer

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

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

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

Errors in surveying and Setting-out

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

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

Improvement of accuracy:

Use of technology to provide checking methods

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

Comparing accuracy of set out element to nationally recognised standards.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Undertake a survey to establish a station network for horizontal and vertical control</td><td rowspan="4">LO1 and LO2
D1 Assess the accuracy of a network in the production of a topographic survey</td></tr>
<tr><td>P1 Describe the types of control networks that are available for surveying, including examples of local and national stations
P2 Carry out a closed traverse survey of a network, including at least five stations
P3 Calculate corrected co-ordinates and heights for the stations and explain the stages used</td><td>M1 Calculate and compare the accuracy achieved in a closed traverse survey</td></tr>
<tr><td colspan="2">LO2 Explain the process of undertaking a topographic survey</td></tr>
<tr><td>P4 Explain the process of conducting a topographic survey for a given plot of land, including initial control
P5 Describe, with examples, common coding systems and data exchange processes, including communicating final outcomes</td><td>M2 Review the content of a topographic survey, including analysis of its suitability to assist the design team in completing the design</td></tr>
</table>

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

Recommended Resources

Textbooks

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

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

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

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

Websites

ice.org.uk	Institution of Civil Engineers (General Reference)
tsa-uk.org.uk	The Survey Association (General Reference)

Unit 8: Mathematics for Construction

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

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

Unit code	**J/617/6366**
Unit level	**4**
Credit value	**15**

Introduction

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

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

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

Learning Outcomes

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

1 Use analytical and computational methods to solve construction related problems

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

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

4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis examples.

Essential Content

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

Analytical methods

Trigonometry

irregular areas and volumes

sine rule

cosine rule

area of triangles applications

Trigonometry

coordinate systems

basic trigonometric ratios and their inverses

trigonometric ratios for the four quadrants

solution of triangles

areas and volumes of regular solids

Algebra

Linear

simultaneous and quadratic equations (graphical or algebraic solving)

Matrices

Multiplication

Transposition

inversion (up to 2 x 2)

Application to construction problems

analysis and design issues

processes and operations

resource issues e.g. labour, finance

project planning

levelling, contouring

triangulation, traversing, cut and fill, setting out.

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

Statistical methods

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

Central tendency and dispersion

dispersion (standard deviation, variance, interquartile range)

Distribution theory: normal distribution

confidence limits

Null hypothesis

significance testing.

Construction engineering problems

measures of central tendency (mean, mode, median)

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

grouped and ungrouped data

Probability theory, Binomial and normal distribution

Applications

presentation of data

estimation

prediction

quality control

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

Differential calculus

basic differentiation techniques applied to algebraic, trigonometric and logarithmic functions

products and quotients

function of a function

second order derivatives

the location of stationary values

Integral calculus

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

Practical construction problems

solution of problems involving maxima and minima

growth and decay

centroids

moments of inertia

areas under curves and volumes of revolution

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

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

Trigonometrical techniques

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

Arithmetic progressions

Dimensional analysis

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Use analytical and computational methods to solve construction related problems</td><td rowspan="5">LO1 and LO2
D1 Evaluate analytical and statistical findings from construction problems completed and justify the techniques adopted to solve such problems.</td></tr>
<tr><td>P1 Solve construction problems using trigonometry techniques
P2 Solve construction problems using algebraic techniques</td><td>M1 Apply the use of matrices to solve problems</td></tr>
<tr><td colspan="2">LO2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages</td></tr>
<tr><td>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</td><td>M2 Interpret the results of a statistical hypothesis test conducted from a given scenario</td></tr>
</table>

Pass	Merit	Distinction
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: ax^n, sine ax, cosine ax, $\log_e x$, e^{ax} and methods including function of a function **P6** Use integral calculus techniques to determine indefinite and definite integrals of functions involving ax^n, sine ax, cosine ax, 1/x, and e^{ax}	**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 industry-related problem.
LO4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis examples.		
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

Textbooks

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

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

Websites

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

Unit 18: Civil Engineering Technology

Unit code	**J/615/1404**
Unit level	**4**
Credit value	**15**

Introduction

This unit explores the role of professional civil engineers, their essential involvement in the construction and maintenance of infrastructure, and the key technologies they apply. The technologies and processes of civil engineering, in the development of highways, bridges, drainage systems, substructure and superstructure, are crucial to support contemporary societies.

Topics included in this unit are: earthwork activities, temporary and permanent dewatering procedures, methods and techniques used to create substructures, highways and superstructures and the common hazards, technical problems and solutions associated with modern civil engineering activities.

On successful completion of this unit students will be able to describe, analyse and evaluate modern civil engineering procedures, apply this skill and knowledge to the design of infrastructure and produce solutions to address hazards and problems encountered in civil engineering projects.

Learning Outcomes

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

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

2 Present a site safety plan, risk assessment and method statement for a given civil engineering activity

3 Evaluate a given civil engineering problem and propose a solution

4 Prepare a design proposal for a new infrastructure project.

Essential content

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

Earthworks activities, use and specification of earthmoving equipment

Formation of cuttings and embankments:

Groundwater problems and techniques used to deal with issues of ground and slope stability

Temporary and permanent dewatering techniques

Techniques used in deep excavations and trenching works

Methods and techniques used to create complex foundations

Methods and techniques used in piling works

Methods and techniques used in drainage works

Methods and techniques used in culvert construction

Methods and techniques used in underpasses and utilities.

LO2 **Present a site safety plan, risk assessment and method statement report for a given civil engineering activity**

Health & safety legislation and codes of practice relative to civil engineering site activities, hazards, risks and safety arrangements for excavations:

Hazards, risks and safety arrangements for working in confined spaces

Hazards, risks and safety arrangements for working on structures

Hazards, risks and safety arrangements for working within temporary works on highways

Roles and responsibilities of all parties in civil engineering projects.

Site safety plans

LO3 **Evaluate a given civil engineering problem and propose a solution**

Civil engineering environmental contexts

Civil engineering quality contexts

Civil engineering geotechnical contexts

Civil engineering economic contexts

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

Methods and techniques used to create bridges and the different specifications of bridges:

Flexible highway construction foundation criteria and related geotechnical parameters

Methods and techniques used to create flexible highways

Methods and techniques used in highway link and junction design

Methods and techniques used in flexible pavement design.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the common methods and techniques used in civil engineering earthworks and substructures		
P1 Discuss earthworks activities, equipment and techniques **P2** Describe methods and techniques used to create complex foundations, piling works and drainage works **P3** Describe methods and techniques used in culvert construction, underpass construction and provision for utilities	**M1** Analyse methods and techniques used in large complex earthmoving operations and deep excavations	**D1** Evaluate methods and techniques used to deal with issues of ground and slope stability
LO2 Present a site safety plan, risk assessment and method statement for a given civil engineering activity		
P4 Identify the hazards, risks and safety arrangements for excavations, working in confined spaces, working on structures and for working within temporary works on highways **P5** Develop and present a site safety plan, risk assessments and method statements for a given civil engineering activity	**M2** Discuss Health & Safety legislation and codes of practice related to civil engineering sites	**D2** Justify a site safety plan, risk assessments and method statements report for activities related to a given civil engineering project

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO3 Evaluate a given civil engineering problem and propose a solution</td><td rowspan="5">LO3 and LO4

D3 Justify the selection of specific features in the development of a civil engineering solution to a given problem</td></tr>
<tr><td>P6 Evaluate the environmental, quality, geotechnical and economic contexts of a given civil engineering problem

P7 Propose a solution to a given civil engineering problem</td><td>M3 Illustrate how the environmental, geotechnical, quality and economic contexts of a problem are addressed through a proposal</td></tr>
<tr><td colspan="2">LO4 Prepare a design proposal for a new infrastructure project</td></tr>
<tr><td>P8 Describe methods and techniques used in highway design

P9 Develop a civil engineering design proposal for a new infrastructure project</td><td>M4 Analyse methods and techniques used to create bridge foundations, flexible highway construction foundation criteria and related geotechnical parameters</td></tr>
</table>

Recommended resources

Textbooks

CHUDLEY, R. and GREENO, R. (2012) *Advanced Construction Technology.* 5th ed. Harlow: Pearson.

CHUDLEY, R. and GREENO, R. (2014) *Building Construction Handbook.* 10th ed. Oxford: Butterworth-Heinemann.

MANLEY, S., CHARTERS, M., FRANCIS, C., TOPLISS, S. and DOYLE, M. (2008) *Construction*. Harlow: Pearson.

ROGERS, M. and ENRIGHT, B. (2016) *Highway Engineering*. 3rd ed. Oxford: John Wiley & Sons.

Websites

www.standardsforhighways.co.uk	Standards for Highways (General Reference)
www.ice.org.uk	Institution of Civil Engineers (General Reference)
www.icevirtuallibrary.com	Institution of Civil Engineers 'Virtual Library' (General Reference)

Unit 20: Principles of Structural Design

Unit code	**R/615/1406**
Unit level	**4**
Credit value	**15**

Introduction

Buildings, bridges, roads, and many other types of man-made structures are critical to the economic and social well-being of our societies. We rely upon these structures to provide us with suitable spaces and infrastructure to support our daily lives. This unit explores the fundamental principles of structural design, codes of practice and standards required to construct safe, effective static civil engineering structures commonly used in today's infrastructure projects.

Topics included in this unit are: methods and techniques used to determine bending moments and shear forces in simply supported steel and reinforced concrete beams; deflection in simply supported steel beams; and axial load carrying capacity of steel and reinforced concrete columns.

On successful completion of this unit students will be able to determine and analyse forces within fixed structures and understand the fundamental concepts of structural design.

Learning Outcomes

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

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

2 Determine deflection for simply supported steel beams

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

4 Explore design methods for steel, reinforced concrete beams and columns.

Essential content

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

Loading:

Dead loads

Live loads

Wind loads

Point loads

Uniformly distributed loads.

Elasticity and plasticity of common construction materials:

Factors of safety

Building regulations

Health & safety regulations.

Bending moments:

Bending moment diagrams.

Shear forces:

Shear force diagrams.

LO2 **Determine deflection for simply supported steel beams**

Deflection in supported beams with point loads

Deflection in supported beams with uniformly distributed loading

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

Axial loading:

Steel columns

Reinforced concrete columns

Foundations

Slenderness ratio

Effective length

Material properties

Corrosion resistance

Weathering

LO4 **Explore design methods for steel, reinforced concrete beams and columns**

Limit state design

Steel:

Beam design and selection

Column design and selection.

Reinforced concrete:

Beam design and selection

Column design and selection

Building Information Modelling for structures.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Calculate bending moments and shear forces for simply supported steel and concrete beams</td><td rowspan="2">D1 Evaluate how maximum bending moments determine steel beam selection using current codes of practice and approved documents in terms of economics and safety</td></tr>
<tr><td>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</td><td>M1 Produce valid factors of safety for live loads, dead loads and imposed loads using current codes of practice and building regulations</td></tr>
<tr><td colspan="2">LO2 Determine deflection for simply supported steel beams</td><td rowspan="4">LO2 and LO3

D2 Assess the most effective support method for a given scenario, in terms of ease and speed of construction, economics, safety and environmental factors</td></tr>
<tr><td>P3 Determine deflection in simply supported steel beams with point loads and a uniformly distributed load

P4 Explain how deflection in beams affects structural stability</td><td>M2 Analyse different support methods and their effect on deflection in fixed structures</td></tr>
<tr><td colspan="2">LO3 Calculate the axial load carrying capacity of steel and reinforced concrete columns</td></tr>
<tr><td>P5 Describe the concepts of slenderness ratio and effective length

P6 Determine the axial load carrying capacity of steel columns and reinforced concrete columns</td><td>M3 Analyse the load carrying capacity, size, weight and corrosion resistance properties of different materials used for beams and columns in fixed structures</td></tr>
</table>

Pass	Merit	Distinction
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	**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

Textbooks

ANTHONY, A. et al (2007) *Reynolds's Reinforced Concrete Designer's Handbook.* 11th ed. Abingdon: Taylor & Francis.

DURKA, F. et al (2002) *Structural Mechanics: Loads, Analysis, Design and Materials.* 6th ed. London: Prentice Hall.

FIONA, C. (2008) *Structural Engineer's Pocket Book*. 2nd ed. Oxford: Butterworth-Heinemann.

HULSE, R. and CAIN, J. (2000) *Structural Mechanics*. 2nd ed. London: Palgrave Macmillan.

MCKENZIE, W. (2003) *Design of Structural Elements*. London: Palgrave Macmillan.

MOSLEY, H. (2007) *Reinforced Concrete Design*. 6th ed. London: Palgrave.

OZELTON, E. (2006) *Timber Designers' Manual.* Chichester, West Sussex: Wiley-Blackwell.

SEWARD, D. (2003) *Understanding Structures: Analysis, Materials, Design*. 3rd ed. London: Palgrave Macmillan.

SMITH, P. (2001) *An Introduction to Structural Mechanics.* London: Palgrave Macmillan.

Steel Construction Institute (2005) *Steel Design Manual*. 6th ed. Chichester, West Sussex: Wiley-Blackwell.

Websites

www.ice.org.uk	Institution of Civil Engineers (General Reference)
www.istructe.org	The Institution of Structural Engineers (General Reference)
www.iabse.org	International Association for Bridge and Structural Engineering (General Reference)
www.cices.org	Chartered Institution of Civil Engineering Surveyors (General Reference)

Unit 42: Highway Engineering

Unit code	**K/615/1427**
Unit level	**5**
Credit value	**15**

Introduction

The quick and flexible means of transport, afforded to us by motor vehicles, has transformed modern life. This ease of mobility is afforded by the construction and maintenance of our road system. The increased volume of traffic and the need to have an efficient road network to transport resources requires us to become more proactive in developing innovative highway solutions. In recent years, we have seen the introduction of 'smart motorways' and 'guided bus-ways'; however, we will require more creative and resourceful solutions for the future.

This unit explores the planning, design, construction and maintenance of our road infrastructure; including the supporting structures such as tunnels, bridges and full pavement construction.

On successful completion of this unit students will be able describe a new route process for a highway as well as explaining civil engineering aspects, including pavement types. They will also be able appraise improvements to the existing road infrastructure.

Learning Outcomes

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

1 Evaluate how a new highway route is identified, planned and designed

2 Assess the methods of earthwork operations, bridges and tunnelling which are used in connection with the provision of highways

3 Justify the selection of pavement construction type for a given highway provision

4 Present a report that specifies improvement that can be made to a given highway infrastructure project, including maintenance techniques and planning.

Essential content

LO1 **Evaluate how a new highway route is identified, planned and designed**

Highway identification and planning:

The techniques used for the assessment of potential traffic volumes

Understanding of the different variables which affect potential traffic volumes

Land acquisition procedures for preferred routes, including alignment design

Public consultation arrangements, including Environmental Impact Assessment

Funding arrangements, including any proposed tolls, contributions or other revenue sources.

Highway design:

Horizontal and vertical alignment design of roads

Environmental Impact Assessment requirements within the design

Proposed assessment of interchanges with existing infrastructure, including bridges, tunnels and junctions

Provision and integration of any electronic toll collection infrastructure

Drainage systems, including sustainable urban drainage systems

Knowledge of designing highways for different users.

LO2 **Assess the methods of earthwork operations, bridges and tunnelling which are used in connection with the provision of highways**

Earthwork operations methods:

Accommodation of cut and fill balancing into earthwork operation

Use of ground stabilisation techniques, including lime injection and use of specialised plant for the construction of highways in areas of weak soils

Forming of embankments, including retaining walls and assessment of the soil's angle of repose to stabilise the surrounding rock or soil

Engineering control of earthwork operations

Formation testing.

Bridges:

Formation of abutments

Active and passive span arrangement

Bridge deck and bearing details to be used

Architectural requirements of the structures

Typical types of highway bridges used.

Tunnel provision:

Formation of tunnel, including considerations of cut and cover, pipe jacking, and boring, including use of tunnel boring machines

Soils conditions and proposed destination for surplus material

Maintenance arrangements

Materials used for tunnel linings.

LO3 **Justify the selection of pavement construction type for a given highway provision**

Flexible pavement construction:

Use of dense bitumen macadam, high-density macadam, pervious macadam, mastic asphalt and hot rolled asphalt

Properties of aggregates and uses

Common construction methods

Environmental performance, skid resistance and deterioration

Sub-base materials used and construction technique.

Rigid pavement construction:

Concrete mix details, reinforcement and joint details

Use of pavement trains

Environmental performance, skid resistance and deterioration

Sub-base materials used and construction technique.

LO4 **Present a report that specifies improvements that can be made to a given highway infrastructure, including maintenance techniques and planning**

Improvement to existing highway infrastructure:

Use and effectiveness of 'smart' motorways

Utilisation of redundant infrastructure

Provision of technology to improve public transport systems

Appraising the use and implementation of traffic management systems to prevent congestion.

Maintenance planning and techniques:

Knowledge of common degradation processes for highway structures

Appraising techniques for essential or routine repair to concrete supporting infrastructure

Techniques for renewing worn out pavement surfaces

Techniques for surveying road conditions for the production of repair schedules or asset management.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate how a new highway route is identified, planned and designed		**LO1 and LO2** **D1** Critically analyse design details for the earthwork operations, bridges and tunnelling of a new highway
P1 Analyse how the route of a new section of highway is identified and planned; highlighting the required legal procedures	**M1** Review a schematic design, considering the application of current practice	
LO2 Assess the methods of earthwork operations, bridges and tunnelling which are used in connection with the provision of highways		
P2 Evaluate all the anticipated earthwork operations for a major new highway within a developed sector of a community, including difficult terrain **P3** Prepare an outline design and method statement for the forming of a tunnel section on the proposed new highway	**M2** Discuss the interrelationship between the earthwork operations, bridges and the tunnelling of a new highway	
LO3 Justify the selection of pavement construction type for a given highway provision		**D2** Evaluate the methods and techniques for providing a flexible pavement to a new highway
P4 Select a pavement type to be used and provide a critical analysis to justify your decision **P5** Justify the selection of a pavement construction type	**M3** Compare flexible and rigid pavement construction for a new highway	

Pass	Merit	Distinction
LO4 Present a report that specifies improvements that can be made to a given highway infrastructure, including maintenance techniques and planning		
P6 Present improvements to a given existing and new highway provision **P7** Evaluate common highway faults and highlight effective maintenance regimes as preventative measures for a given project	**M4** Discuss techniques and methods which can improve the effectiveness and conditions of the given highway project	**D3** Critically evaluate a report on improvements to a highway infrastructure scheme, including alternative actions that could be taken

Recommended resources

Textbooks

O'FLAHERTY, C. (2002) *Highways: The Location, Design, Construction & Maintenance of Pavements*. 4th ed. Oxford: Butterworth-Heinemann.

ROGERS, M. (2008) *Highway Engineering*. 2nd ed. Oxford: Blackwell Publishing.

WATSON, J. (1994) *Highway Construction & Maintenance*. 2nd ed. Harlow: Longman.

Websites

www.highways.gov.uk	Highways England (General Reference)
www.theihe.org	The Institute of Highways Engineers (General Reference)

Unit 43: Hydraulics

Unit code	**M/615/1428**
Unit level	**5**
Credit value	**15**

Introduction

The action, management and distribution of fluids, in relation to built structures, is critical. In civil engineering, it is necessary to ensure that we are able to manage the pressures that water may put on structures, either through its flow or the forces exerted and how to resist these. In building services, the balance between necessary pressures to ensure flow and distribution of fluids (through heating/cooling systems or domestic water supplies), and the sizing of pipes to support this flow, will determine efficiency and effectiveness of a system.

However, fluids are dynamic; their behaviour changes based on a range of factors. Thus, the ability to estimate and manage their forces, rates of flow and suitable systems for control requires specialised calculations, equipment and maintenance.

Through this unit students will explore principles of hydrostatic and hydrodynamic fluids, calculate a range of factors and use these calculations to arrive at practical hydraulic solutions.

Learning Outcomes

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

1 Apply concepts of physics to develop solutions for hydrostatic and hydrodynamic problems

2 Calculate forces related to fluids at rest and in motion

3 Develop practical solutions for the distribution of fluids within correctly sized pipes

4 Calculate the hydrostatic pressure exerted on substructures for a given context.

Essential Content

LO1 **Apply concepts of physics to develop solutions for hydrostatic and hydrodynamic problems**

Fluid properties:

Density

Viscosity.

Fluid behaviour:

Viscous flow

Laminar flow

Turbulence

Boundary layer.

LO2 **Calculate forces related to fluids at rest and in motion**

Flow calculation:

Bernoulli's equation

Hydraulic radius

Velocity distribution

Reynolds number.

Energy:

The energy principle

The energy equation

Hydraulic grade

Energy grade

Energy loss/gain

Friction losses.

LO3 **Develop practical solutions for the distribution of fluids within correctly sized pipes**

Flow in pipes:

Darcy-Weisback equation

Chezy's equation (Kutter's equation)

Discharge

Head loss

Pipeline discharge

Orifice equation.

Open channel flow:

Steady/uniform flow

Manning's equation

Specific energy/critical depth

Subcritical/supercritical flow

Non-uniform flow.

LO4 **Calculate the hydrostatic pressure exerted on substructures for a given context**

Hydrostatic pressure:

Forces on plane

Forces on submerged surfaces

Pascal's law.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems		**LO1. LO2 and LO3** **D1** Assess pipework sizes to determine their efficiency in a given context
P1 Evaluate a hydraulic condition in order to determine the parameters of the problem **P2** Illustrate a proposed solution to a hydraulic problem, using drawings or models	**M1** Compare proposed solutions to a hydraulics problem, highlighting the merits of different solutions	
LO2 Calculate forces related to fluids at rest and in motion		
P3 Solve a Darcy-Weisback equation for a given pressure pipe system **P4** Solve a Manning's equation for given open channel flow situation	**M2** Discuss the differences and similarities between different types of hydrodynamic systems and calculations	
LO3 Develop practical solutions for the distribution of fluids within correctly sized pipes		
P5 Calculate the head loss for a given pipeline **P6** Define pipe sizes for a given set of flow parameters	**M3** Evaluate pipe sizes to determine the flow type that will occur	
LO4 Calculate the hydrostatic pressure exerted on substructures for a given context		**D2** Present proposals for subsurface structures in response to the hydrostatic pressure of a given context
P7 Calculate the pressure exerted on a foundation wall in a given context **P8** Calculate 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

Textbooks

DOUGLAS, J.F. (2011) *Fluid Mechanics*. London: Prentice Hall.

HALL, F. and GREENO, R. (2015) *Building Services Handbook*. London: Routledge.

MASSEY, B.S., BERNARD S, and WARD-SMITH, A.J. (2012) *Mechanics of Fluids*. London: Spon Press.

STROUD, K.A. and BOOTH, D.J. (2013) *Engineering Mathematics*. London: Palgrave Macmillan.

WYNN, P. (2014) *Hydraulics for Civil Engineers*. London: ICE Publishing.

Unit 47: Construction Data Management

Unit code	**T/615/1432**
Unit level	**5**
Credit value	**15**

Introduction

A tremendous amount of information is shared, stored, managed and created as part of a complex construction project. It is for this reason that data management forms a critical component to the future of the construction industry. The skills required to be able to effectively manage and review this information intelligently are equally critical. This unit will draw upon the main concepts surrounding Building Information Management (BIM) and further explore the importance of information management.

This unit will detail the processes required to effectively communicate the information required by the client, or asset owner, and how to ensure data is managed throughout a project with the relevant skills and requirements necessary to avoid duplication, error or missing information.

The knowledge, skills and understanding of the importance of data within a BIM-enabled project is critical for the success of the project and students will begin to explore ways in which this process is managed intelligently and supported across a project lifecycle.

Learning Outcomes

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

1 Assess the importance of information management within the construction industry

2 Evaluate the role of information management and how it can benefit and support intelligent information exchanges

3 Illustrate the information delivery cycle, in regard to BIM, and how the information management process aids the design, construction and occupation of an asset

4 Discuss the ways in which information can be captured, shared and managed throughout a project lifecycle.

Essential Content

LO1 Assess the importance of information management within the construction industry

The relevance of information management and how it can aid in the construction process

The importance of managing information during the design, construction and operation phases of an asset

Tools and processes to effectively manage information across a project lifecycle

Technology that supports effective information management

Post-occupancy evaluation and managing the information once a built asset is in use

The basic principles of 'Soft Landings' and how this can be applied at the very early stages of a project

LO2 Evaluate the role of information management and how it can benefit and support intelligent information exchanges

A thorough evaluation of the definition of information management

The importance of the role of information management in regard to BIM

Tasks that must be undertaken to ensure effective information management and exchange

Roles and responsibilities that support information management

Supporting and collating information across all stages of a project

Information management and collaborative working

Client roles and responsibilities

Information exchange formats

Monitoring progress

LO3 **Illustrate the information delivery cycle, in regard to BIM, and how the information management process aids the design, construction and occupation of an asset**

The requirements of information delivery across all stages

Data drops and a plan of work

Formats, schedules, and information exchanges

The importance of 'Plain Language Questions'

The employer's information requirements (EIR) and defining information deliverables

Supplier assessment and capability, and ways in which this can be achieved

Pre-qualification and BIM

Tendering on a BIM project

The pre- vs post-contract BIM Execution Plan; information requirements

Supplier responsibilities and the delivery of the individual discipline information

Task team information plans (TIDPs)

The master information delivery plan (MIDP)

Collating the data at handover

LO4 **Discuss the ways in which information can be captured, shared and managed throughout a project lifecycle**

Defining information exchange deliverables against an LOD matrix, or design responsibility matrix

Federation of geometric and non-geometric data, the key differences

The importance of consistent exchange formats to federate project information

The Common Data Environment (CDE) and sharing, archiving and storing data

Storing data post-occupation

Security and managing the built asset information

The asset information model and updating information during the occupation of an asset

Information exchange formats and examples of these

Defining data drops at key decision points.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Assess the importance of information management within the construction industry</td><td rowspan="4">LO1 and LO2

D1 Critically evaluate the way that information exchange formats, deliverables and processes benefit stakeholders by increasing the accuracy of information</td></tr>
<tr><td>P1 Assess how information should be intelligently managed across a project

P2 Discuss the importance of information management and how it relates to the BIM process</td><td>M1 Review information management techniques that can positively affect a building or infrastructure project

M2 Evaluate the tools available to effectively manage information across an asset portfolio</td></tr>
<tr><td colspan="2">LO2 Evaluate the role of information management and how it can benefit and support intelligent information exchanges</td></tr>
<tr><td>P3 Evaluate the role of information management and the key requirements of this role in regard to a building project

P4 Evaluate how information management is supported by the key concepts relating to collaborative working</td><td>M3 Review the responsibilities of an assigned ‘information manager’ for a project and how these responsibilities differ from the roles that are traditionally appointed on a project</td></tr>
</table>

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO3 Illustrate the information delivery cycle in, regard to BIM, and how the information management process aids the design, construction and occupation of an asset</td><td rowspan="5">LO3 and LO4

D2 Evaluate the differences between the current forms of a Common Data Environment (CDE) and create an implementation plan on behalf of an owner</td></tr>
<tr><td>P5 Discuss how the information delivery cycle can aid and support a project across all stages

P6 Illustrate how information is shared and managed in line with an information delivery cycle</td><td>M4 Review how information will be transferred across a project during the design and construction stage and into the asset management stage</td></tr>
<tr><td colspan="2">LO4 Discuss the ways in which information can be captured, shared and managed throughout a project lifecycle</td></tr>
<tr><td>P7 Assess ways in which information can be captured from a variety of sources, including BIM authoring tools

P8 Discuss the information deliverables that may be relevant to an asset</td><td>M5 Analyse ways in which information can be collated and ‘checked’ on behalf of an asset owner to ensure asset information and information deliverables have been captured by suppliers</td></tr>
</table>

Recommended resources

Textbooks

EASTMEN, C., TEICHOLZ, P., SACKS, R. and LISTON, K. (2011) *BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors.* 2nd ed. John Wiley & Sons Inc.

FAIRHEAD, R. (2013) *Information Exchanges: RIBA Plan of Work 2013 Guide.* London: RIBA Publishing.

HOLZER, D. (2016) *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering and Construction*. Chichester, West Sussex: John Wiley & Sons Inc.

MORDUE, S., PHILP, D. and SWADDLE, P. (2015) *Building Information Modelling for Dummies*. Chichester, West Sussex: John Wiley & Sons Inc.

SAXON, R. (2016) *BIM for Construction Clients.* London: RIBA Publishing.

SHEPHERD, D. (2015) *BIM Management Handbook*. London: RIBA Publishing.

Websites

www.theb1m.com	The B1M (General Reference)
www.bimtaskgroup.org	The BIM Task Group (General Reference)
www.bimtaskgroup.org	The BIM Task Group 'COBie UK 2012' (General Reference)
www.thenbs.com	NBS 'BIM (Building Information Modelling)' (General Reference)