

# T LEVEL

*Technical Qualification  
in Design, Surveying and  
Planning for Construction*

## Specification

First teaching September 2025

Version 1.0

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# **T Level Technical Qualification in Design, Surveying and Planning for Construction (Level 3)**

## **Specification**

First teaching September 2025

Version 1.0



Pearson

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# 1 Introducing the qualification

## T Level programme

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T Levels are two-year, Level 3 study programmes that follow the study of GCSEs and Technical Awards and offer an alternative to A Levels and Apprenticeships.

T Levels combine classroom theory, practical learning and a minimum 315 hours of industry placement with an employer. The work placement ensures students have real experience of the workplace.

T Level programmes are developed in collaboration with employers so that the content meets the needs of industry and prepares students for work. T Levels provide the knowledge and experience needed to progress to highly skilled employment, an Apprenticeship or higher-level study, including university.

## Understanding the Specification and Administrative Guide

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This specification should be read in conjunction with the Administrative Guide for Delivery and Assessment. The specification contains all the information you need to teach the technical qualification including content and assessment details. The Admin Guide contains the information and references you need to register as a provider, register students and administer their results. It also contains grading information and information on resources.

## What is the Technical Qualification (TQ)?

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The *T Level Technical Qualification in Design, Surveying and Planning for Construction* is the main classroom-based element of the T Level. Students will learn using a curriculum that has been shaped by industry experts.

During the two-year programme, students will acquire the core knowledge that underpins each industry. They will develop occupationally specific skills that will allow them to enter skilled employment within a specific occupation.

# Technical Qualification and Outline Content

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The Outline Content for the *T Level Technical Qualification in Design, Surveying and Planning for Construction* has been produced by T Level panels of employers, professional bodies and Providers. It is based on the Apprenticeship Standards.

Pearson has used the Outline Content to form the basis of the Technical Qualification specification. This includes:

- elaboration of the Outline Content to produce a specification that gives Providers an accurate interpretation of what needs to be taught and assessed
- enabling students to achieve threshold competence in relation to the Occupational Specialist components
- the integration of English, maths and digital competencies.

## Employer and Provider panels

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Pearson engaged with employer and Provider panels throughout the development of the Technical Qualification. This ensured:

- the content gives students quality preparation to help them progress
- assessments are realistic and assess the knowledge and skills that are important to employers
- the technical qualification meets the needs of Providers.

Pearson is grateful to all university and further education lecturers, teachers, employers, professional body representatives and other individuals who have generously shared their time and expertise to help us develop these new qualifications.

Employers, professional bodies and Providers who contributed to the development of the Technical Qualification include:

- Arup
- Balfour Beatty
- BAM Nuttall
- Cast Consultancy
- Chartered Institution of Building Services Engineers
- HEMSEC Manufacturing Ltd
- Institution of Civil Engineers
- Kier Group
- London South Bank University
- Lovell Homes Partnership
- Low Carbon Construction
- Portsmouth University
- Royal Institution of Chartered Surveyors
- Structural Timber Association



- TDO Architecture
- Technician Apprenticeship Consortium
- Thames Labs.

## Qualification purpose

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This Technical Qualification is for T Level students who are undertaking the *T Level in Design, Surveying and Planning for Construction*. It is intended for students who want to progress to a career in the construction sector, with a focus on design and surveying.

The purpose of the *T Level Technical Qualification in Design, Surveying and Planning for Construction* (Level 3) is to ensure students have the knowledge and skills needed to progress into highly skilled employment, an Apprenticeship or higher-level study, including university, within the specialist area of design and surveying.

At the end of the Technical Qualification, students are expected to demonstrate threshold competence, meaning that they have gained the core knowledge and skills related to construction design and surveying and are well placed to develop full occupational competence with additional development and support once in employment in the construction sector.

## Student profile and progression

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Students undertaking this Technical Qualification will be 16–19 years old and in full-time education.

The typical student has:

- a clear idea about the industry sector in which they wish to pursue a career
- an idea of the type of job role they would like to explore as a career.

This Technical Qualification aligns to the Level 3 Apprenticeships Building Services Engineering Senior Technician (Building Services Design), Civil Engineering Technician, Railway Engineering Design Technician (Civil Engineering), Geospatial Technician, Surveying Technician and Digital Engineering Technician (Surveying and Design).

The qualification therefore supports progression to entry-level job opportunities in the construction sector, with a focus on Surveying and Design, Civil Engineering, Building Services Design.

Job roles could include:

- Surveying Technician
- Civil Engineering Design Technician
- Digital Engineering Technician
- Civil Engineering Technician
- Building Services Engineering Design Technician
- Architectural Technician
- Construction Design Coordinator
- Transport Planning Technician
- Rail Engineering Design Technician.

Alternatively, students could progress to apprenticeships such as those mentioned above to develop and gain certification of full occupational competence, or they could progress to higher-level Apprenticeships such as the Level 4 Construction Site Engineering Technician, Construction Quantity Surveying Technician, Construction Design and Build Technician, Building Services Engineering Technician, Construction Site Supervisor, Acoustics Technician, and Level 6 Building Control Surveyor, Building Services Design Engineer, Building Services Engineering Site Management, Chartered Surveyor, Civil Engineer, Civil Engineering Site Management, Construction Quantity Surveyor, Construction Site Manager, Design and Construction Management, Architectural Assistant depending on their skills or experience.

Where students may not have access to an Apprenticeship or would prefer a more academic route, they could progress to relevant Higher National Certificate (HNC) or Higher National Diploma (HND) programmes or construction degree programmes such as Civil Engineering, Construction Management, Construction Surveying, Building Services Engineering, Construction Design and Architecture.

Students must check the entry requirements for each degree programme with the relevant higher education provider.

## 2 Qualification summary and structure

### Summary

Qualification title	T Level Technical Qualification in Design, Surveying and Planning for Construction (Level 3)
Qualification number (QN)	610/5310/7
First teaching	September 2025
Total Guided Learning Hours (GLH)	1200 hours (600 hours core)
Total Qualification Time (TQT)	1470 hours (810 hours core)
Occupational Specialism(s)	<ul style="list-style-type: none"> <li>· Surveying and Design for Construction and the Built Environment (600 GLH, 660 TQT)</li> <li>· Civil Engineering (600 GLH, 660 TQT)</li> <li>· Building Services Design (600 GLH, 660 TQT)</li> </ul>
Components and weighting	<p>Core Component = 50% of total qualification - made up of:</p> <ul style="list-style-type: none"> <li>· Core Paper 1 = 17% of total qualification (33% of core)</li> <li>· Core Paper 2 = 17% of total qualification (33% of core)</li> <li>· Core ESP = 17% of total qualification (33% of core)</li> </ul> <p>Occupational Specialism = 50% of total qualification</p>
Recommended age range	16–19
Grading information	<p>Core and Employer Set Project (ESP) components are graded A*–E or unclassified.</p> <p>Occupational Specialism (OS) component is graded Pass, Merit, Distinction or unclassified.</p> <p>The overall grading is on a scale of Pass, Merit, Distinction, Distinction* or Unclassified. The overall grade is awarded by the Institute for Apprenticeships &amp; Technical Education (IfATE).</p>

Qualification title	T Level Technical Qualification in Design, Surveying and Planning for Construction (Level 3)
Entry requirements	<p>There are no formal prior learning requirements. It is the Provider's responsibility to ensure students recruited have a reasonable expectation of success.</p> <p>Students are most likely to succeed if they have qualifications at Level 2 (for example, five GCSEs at grade 4 and above including English and maths or a vocational Tech Award pass at Level 2).</p> <p>Students may demonstrate the ability to succeed in various ways. For example, they may have relevant work experience or may have shown specific aptitude through diagnostic tests or other non-educational experience.</p>
Assessment	<ul style="list-style-type: none"> <li>• All assessments are externally set and marked by Pearson.</li> <li>• The core and ESP components are externally set and marked by Pearson.</li> <li>• The OS components are externally set and marked by Pearson.</li> </ul>

# Assessment Structure

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* has two mandatory components.

## 1. Core component

This component covers the underpinning knowledge, concepts and skills that support threshold competence in the construction industry.

The content for the Core component is provided in *Section 3*.

Assessment component	Assessment method	Duration	Marks	Weighting	Timetable	Availability
Core Paper 1	Written examination	2.5 hours	100	33%	Set date and time	May/June November
Core Paper 2	Written examination	2.5 hours	100	33%	Set date and time	May/June November
Employer Set Project	Externally set project	15 hours 30 minutes	100	33%	Windowed	May/June November

## 2. Occupational Specialism components

There are three Occupational Specialist components in this Technical Qualification.

These components cover the Occupational Specialist knowledge and skills required to demonstrate threshold competence for the specialism. The Occupational Specialism is assessed by a skills-related project that synoptically assesses the Performance Outcome skills and associated underpinning knowledge.

The content for the Occupational Specialist component is provided in *Section 4*.

Assessment component	Assessment method	Duration	Marks	Weighting	Timetable	Availability
Surveying and Design for Construction and the Built Environment	Externally set project	30 hours	180	100%	Set date/ time and windowed	May/June
Civil Engineering	Externally set project	25 hours	180	100%	Set date/ time and windowed	May/June
Building Services Design Production	Externally set project	20 hours 40 minutes	180	100%	Set date/ time and windowed	May/June

## What does the qualification cover?

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The Technical Qualification content has been designed from the Outline Content created by the Institute for Apprenticeships & Technical Education and the Construction T Level panel.

We have used the Outline Content to create the Technical Qualification specification and assessment, which has been validated by our own panel of construction employers and education Providers to ensure it is appropriate for the progression routes identified in the above section.

Students learn about the following topics:

- Health and safety
- Science
- Measurement
- Building technology
- Information and data
- Digital technology
- Construction mathematical techniques
- Design
- Construction and the built environment industry
- Sustainability
- Relationship management
- Commercial business
- Project management
- Law.

# 3 Core Component

The content of the Core component has the core skills mapped to where there are opportunities to develop them. The competencies and skills are not expected to be developed at every point where they are mapped, but using this guidance tutors will embed them into teaching to prepare students for the assessments in the Core component.

The core skills are assessed through the Employer Set Project. The core skills for this Core component are as follows.

## **Core Skill 1 (CS1) – Communication**

For this skill students will:

- Produce reports and presentations for construction professionals, clients or for non-technical audiences such as the public.
- Produce sketches and drawings that include technical details for use by a client, contractor or as part of a planning application.
- Produce rendered drawings and illustrations that could be used for marketing a development to the public or similar stakeholders.
- Participate in question and answer sessions and respond to questions from a range of different types of stakeholders.
- Present ideas and concepts for design proposals as part of a group to stakeholders.
- Produce rendered drawings and internal plans in response to design briefs and contexts.
- Generate reports that consider the feasibility of a new development or refurbishment project.
- Present results of a PESTLE analysis for a proposed project.

## **Core Skill 2 (CS2) – Work with others**

For this skill students will:

- Participate in group discussions to determine the format of information that is appropriate for different types of stakeholder, taking into consideration verbal, written and drawn details.
- Work with stakeholders to determine project outcomes and required deliverables for stages of a construction project.
- Work in pairs or small groups to complete research activities in to existing construction projects.
- Work as part of a team to produce and assemble a tender for a project.

### **Core Skill 3 (CS3) – Applying a logical approach to solving problems, identifying issues and proposing solutions**

For this skill students will:

- Produce planning documentation for existing construction projects.
- Investigate projects to identify reasons why projects do not always run to plan and to suggest alternatives.
- Produce designs for a range of different types of project, including domestic dwellings, commercial, industrial and civil engineering developments.
- Produce documentation for use during construction activities, such as method statements.
- Use case studies to complete a cost-benefit analysis for an infrastructure project.
- Follow standard processes to produce unit rates, bills of quantities and other costing documentation.
- Be able to interpret client vision and specification to produce outline design proposals to meet client needs.

### **Core Skill 4 (CS4) – Primary research**

For this skill students will:

- Work with partners to collect dimensional information to complete calculations of perimeters, areas and volumes.
- Complete tests on materials to determine qualities such as modulus of elasticity.
- Use test instruments to verify values achieved theoretically for electrical circuits.
- Research local environments to complete land use surveys.
- Collect and interpret statistical data, such as traffic counts to determine levels of traffic on an existing road where a bypass is proposed.
- Work as part of a team to produce and assemble a tender Documentation.



## **Content summary**

The core content covers the knowledge, understanding and application of contexts, concepts, theories and principles relating to the following areas:

1. Health and safety
2. Science
3. Measurement
4. Building technology
5. Information and data
6. Digital technology
7. Construction mathematical techniques
8. Design
9. Construction and the built environment industry
10. Sustainability
11. Relationship management
12. Commercial business
13. Project management
14. Law

# Content

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## Content Area 1: Health and Safety

Students must be able to apply an understanding of health and safety issues in the construction sector in a range of design, surveying and planning contexts. They must explore how legislation and regulations impact on organisations, individuals and society as a whole, including the role of the Health and Safety Executive.

<b>Content area 1: Health and Safety</b>	
CK1.1	<p><b>1.1 Students must understand the roles, responsibilities, enforcement, penalties for non-compliance and required documentation for current health and safety legislation and regulations that apply to design, surveying and planning for construction</b></p> <p>1.1.1 The Health and Safety at Work etc. Act, the role of the Health and Safety Executive (HSE) and the penalties the HSE can impose for non-compliance with legislation.</p> <p>1.1.2 The Control of Substances Hazardous to Health (COSHH) Regulations, the types of substance that are hazardous to health and the types of exposure and control measures that can be used to reduce risks.</p> <p>1.1.3 The Work at Height Regulations, planning activities, equipment and PPE requirements.</p> <p>1.1.4 The Construction (Design and Management) Regulations, the production of pre-construction information, construction phase safety plans and contents of a health and safety file. <b>(E2, E4, D2, CS1)</b></p> <p>1.1.5 The Workplace (Health, Safety and Welfare) Regulations relevant to construction projects.</p> <p>1.1.6 The Manual Handling Operations Regulations, the requirement to avoid hazardous manual handling where reasonably practicable and the use of lifting assessments and machinery or mechanical aids.</p> <p>1.1.7 The Management of Health and Safety at Work Regulations and risk assessment requirements under Regulation 3 of the legislation.</p>
CK1.2	<p><b>1.2 Students must understand the principles of liability</b></p> <p>1.2.1 Public liability: injury, illness and death of third parties and damage to the property of a third party.</p> <p>1.2.2 Employer liability: employee illness, injury, accidents and compensation.</p>

CK1.3	<p><b>1.3 Students must understand and apply HSE approved codes of practice</b></p> <p>1.3.1 The use of Approved Codes of Practice (ACOP) – legal reference L series books from the HSE and application of Managing Health and Safety in Construction.</p>
CK1.4	<p><b>1.4 Students must understand the implications of poor health and safety performance and the benefits of addressing poor health and safety for design surveying and planning in construction</b></p> <p>1.4.1 The possible implications of and penalties for non-compliance with health and safety regulations.</p> <ul style="list-style-type: none"> <li>· Legal and financial: <ul style="list-style-type: none"> <li>○ enforcement, sanctions, loss of reputation, loss of work, corporate manslaughter</li> <li>○ magistrates and crown court penalties – fines and imprisonment.</li> </ul> </li> </ul> <p>1.4.2 The possible implications of and penalties for non-compliance with health and safety regulations.</p> <ul style="list-style-type: none"> <li>· Ethical and environmental: <ul style="list-style-type: none"> <li>○ duty of care; moral and ethical obligation to keep people safe</li> <li>○ obligation to care for the environment.</li> </ul> </li> </ul> <p>1.4.3 The benefits of undertaking safety reviews, including:</p> <ul style="list-style-type: none"> <li>· reduction in costs</li> <li>· improved reputation of the company</li> <li>· improved employee morale</li> <li>· improved performance in terms of production. <b>(CS3)</b></li> </ul>
CK1.5	<p><b>1.5 Students must understand the development of safe systems of work</b></p> <p>1.5.1 The approaches used to develop safe systems of work in construction workplaces, including the production and use of risk assessment, method statements, company-specific procedures and permits to work. <b>(CS3)</b></p>

CK1.6	<p><b>1.6 Students must understand the need for safety-conscious behaviours used in construction</b></p> <p>1.6.1 Why safety-conscious behaviours produce fewer accidents and incidents.</p> <p>1.6.2 The application and implications of:</p> <ul style="list-style-type: none"> <li>· following safe systems of work</li> <li>· reporting potential hazards</li> <li>· poor housekeeping. <b>(D4)</b></li> </ul> <p>1.6.3 The need to review safety systems by using data to establish where unplanned events occur, and how this reduces the chance of future incidents, including analysis of the following types of accident information:</p> <ul style="list-style-type: none"> <li>· trends in near misses and types of accident</li> <li>· comparison with UK national accident data</li> <li>· discussion with workforce, site safety meetings, interviews and safety committees</li> <li>· suggestions and recommendations for improvements, justified by statistical analysis. <b>(CS3, CS2, CS1)</b></li> </ul>
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## Content Area 2: Science

Students must be able to apply an understanding of the range of materials used by the construction sector in a range of design, surveying and planning contexts. They must explore how materials behave while they are under load, and perform calculations related to structural members under various loading conditions. Students also need to understand the principles of human comfort and apply theories to contextualised problems. Students will also gain an understanding of earth sciences and their impact on the construction industry, specifically in a range of design, surveying and planning contexts.

Content area 2: Science	
CK2.1	<p><b>2.1 Students must understand material properties, chemical composition, degradation, failure and effects of environmental conditions</b></p> <p>2.1.1 How different materials behave, material properties, composition and causes of failure and degradation in order to discriminate between materials and select appropriately.</p> <ul style="list-style-type: none"> <li>• Material properties: mass, density, compressive strength, tensile strength, shear strength, hardness, toughness, stiffness, workability, resistance to moisture/vapour penetration, resistance to degradation/oxidisation.</li> <li>• Chemical composition (structure) of materials: timber, concrete, plastics, metals.</li> <li>• Degradation: natural agents, timber infestation, timber decay, chemical degradation.</li> <li>• Modes of failure: fatigue, creep, buckling, bending, shear.</li> <li>• Effects of environmental conditions: moisture movement, exposure conditions, freeze-thaw, thermal ageing.</li> <li>• Remedial measures to prevent and reduce degradation: special paints, preservatives, special coatings.</li> </ul> <p>2.1.2 Key properties of construction materials, how they work together to provide composite performance and properties, how they impact on performance in use and on the specification of materials for different scenarios and levels of exposure to the elements.</p> <ul style="list-style-type: none"> <li>• Bricks – facings, Class A engineering, Class B engineering, commons.</li> <li>• Concrete – prescribed mixes, design mixes.</li> <li>• Reinforced concrete – pre-stressed concrete, types of reinforcement, pre-cast, cast in situ.</li> <li>• Concrete blocks – aerated, high-density, insulated.</li> <li>• Mortar mixes – cement mortar, cement lime mortar, coloured mortar.</li> <li>• Plasterboard.</li> <li>• Glass and glass finishes – smart glass (thermochromic, electrochromic, photochromic), laminated, tempered, float, clear, obscured.</li> </ul>

	<ul style="list-style-type: none"> <li>• Insulation materials – fibreglass, expanded polystyrene, thermal insulation boards, mineral wool, cellulose, straw, polyurethane.</li> <li>• Plastics used for polythene damp-proof membranes (DPM), damp-proof courses (DPC), doors and window frames, soffits, bargeboards, fascia, guttering.</li> <li>• Polyvinyl chloride (PVC), unplasticised polyvinyl chloride (uPVC).</li> <li>• Timber and manufactured boards – hardwoods, softwoods, plywood, chipboard, particle board, medium-density fibreboard (MDF).</li> <li>• Roofing materials – slate, concrete, pantile, roofing felt, thatch, ridge, lead flashing.</li> <li>• Engineered timber – glulam beams, engineered joists, engineered beams, eco joists.</li> <li>• Metals: steel (mild, stainless, high-strength), aluminium alloys, copper, brass.</li> </ul>
CK2.2	<p><b>2.2 Students must understand the structural science of how loads and forces act on buildings</b></p> <p>2.2.1 Forces – tension, compression, shear, bending. <b>(M2, M3, M4, M8)</b></p> <p>2.2.2 Stress and strain – shear, compressive, tensile. <b>(M2, M3, M4, M8)</b></p> <p>2.2.3 Loadings on simply supported beams – point, uniformly distributed (UDL). <b>(M2, M3, M4)</b></p> <p>2.2.4 The material and types of structural element – beams, columns, struts and ties.</p> <p>2.2.5 Calculations including forces, stress, strain, Young’s modulus and beam reactions. <b>(M2, M3, M4, M8)</b></p>
CK2.3	<p><b>2.3 Students must understand the principles of electricity</b></p> <p>2.2.6 Generation of electricity, types of power station and their advantages and disadvantages:</p> <ul style="list-style-type: none"> <li>• non-renewable – coal, oil, gas, nuclear</li> <li>• renewable – solar, wind, tidal/hydro.</li> </ul> <p>2.2.7 AC and DC voltage, an understanding of the relationship between voltage, current and resistance (Ohm’s Law), electrical power, energy, efficiency and work done. <b>(M2, M3, M4, M8)</b></p> <p>2.2.8 Transformation:</p> <ul style="list-style-type: none"> <li>• principles of electro-magnetic induction</li> <li>• applications of transformers: step-up and step-down transformers. <b>(M2, M3, M4)</b></li> <li>• primary and secondary currents and voltages</li> </ul>

	<p>2.2.9 Use of formulae for calculations involving:</p> <ul style="list-style-type: none"> <li>· Ohm's Law</li> <li>· power</li> <li>· energy</li> <li>· electrical efficiency</li> <li>· transformer equations. <b>(M2, M3, M4, M8)</b></li> </ul>
CK2.4	<p><b>2.4 Students must understand the principles of heat in design surveying and planning</b></p> <p>2.4.1 Heat transfer mechanisms – conduction, radiation. <b>(M2, M3, M4)</b></p> <p>2.4.2 Properties of air – air temperature, air density, humidity. <b>(M2, M3, M4)</b></p> <p>2.4.3 Condensation – sources of condensation, effects of condensation, types of condensation, methods of controlling condensation.</p> <p>2.4.4 Causes of heat loss – through the fabric of the building, ventilation thermal bridging, air changes.</p> <p>2.4.5 Factors affecting rates of heat loss – temperature differences, surface area, material heat transfer properties, air change rates, solar gain.</p> <p>2.4.6 Thermal conductivity and resistance – U-values, insulation materials. <b>(M2, M3, M8)</b></p> <p>2.4.7 Calculations involving thermal conductivity and resistance, heat loss. <b>(M2, M3, M8)</b></p>
CK2.5	<p><b>2.5 Students must understand the principles of light in design surveying and planning</b></p> <p>2.5.1 Types of light and flow of light energy: electromagnetic spectrum, artificial and natural light.</p> <p>2.5.2 Refraction, diffraction and reflection.</p> <p>2.5.3 Glare, directed and reflected light.</p> <p>2.5.4 Daylight factor – sky component, externally reflected component and internally reflected component.</p> <p>2.5.5 Calculation of illuminance using the inverse square law, including application of units. <b>(M2, M3, M4, M8)</b></p>
CK2.6	<p><b>2.6 Students must understand the principles of acoustics in design surveying and planning</b></p> <p>2.6.1 Reverberation and reverberation time.</p> <p>2.6.2 Comfort levels – noise pollution, personal factors, building regulations, external sources of sound and noise.</p> <p>2.6.3 Privacy and approaches to sound insulation – structural elements, controlling flanking sound and use of materials.</p>

CK2.7	<p><b>2.7 Students must understand types of earth science and how these impact on design, surveying and planning</b></p> <p>2.7.1 Physical geography – groundwork, water levels, investigation methods, land use. <b>(CS4)</b></p> <p>2.7.2 Hydrology:</p> <ul style="list-style-type: none"> <li>· water cycle – evaporation, condensation, precipitation, infiltration, surface run-off</li> <li>· rivers, reservoirs, lakes.</li> </ul> <p>2.7.3 Geology:</p> <ul style="list-style-type: none"> <li>· ground conditions, including methods of investigation (bore holes, pits, trenches)</li> <li>· structure of the ground, including types of rocks, soils, clay</li> <li>· groundwater: water tables, springs, watersheds, aquifers. <b>(CS4)</b></li> </ul> <p>2.7.4 Earth forces and natural phenomena, including effects and impacts on the built environment of:</p> <ul style="list-style-type: none"> <li>· earthquakes – scales and magnitude, earthquake zones</li> <li>· landslides – effects of shear strength of soils, methods of stabilising land (geosynthetic injection, steel or concrete reinforcement, ground anchors)</li> <li>· tidal surges – effects of currents, approaches to reducing effects (storm surge barriers, sea walls, tidal lagoons, closure dams).</li> </ul> <p>2.7.5 Weather and climate – rainfall, temperatures, sunlight, wind, frost. <b>(M5, CS4)</b></p>
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## Content Area 3: Measurement

Students must be able to apply an understanding of different types of measurement and standards, including the processes involved with the production of documentation, as applicable to the construction sector in a range of design, surveying and planning contexts. They must explore the standard units of measurement associated with construction and be able to complete calculations where standard measurements and units are applied.

Content area 3: Measurement	
CK3.1	<p><b>3.1 Students must understand the benefits of accurate and appropriate measurement on built environment performance</b></p> <p>3.1.1 Advantages of accurate and appropriate measurement and reporting. <b>(M1, M8)</b></p> <p>3.1.2 Measurement and reporting of performance indicators – building running costs, flexibility of space, reliability of systems. <b>(M1, M8, CS1)</b></p>
CK3.2	<p><b>3.2 Students must understand and apply types of measurement and mensuration techniques</b></p> <p>3.2.1 Different types of measurement, techniques for measurement associated with these measurements, including:</p> <ul style="list-style-type: none"> <li>· electrical</li> <li>· dimensional</li> <li>· sound</li> <li>· force, stress, strain and pressure</li> <li>· temperature. <b>(M3, M4)</b></li> </ul>
CK3.3	<p><b>3.3 Students must understand measurement standards, guidance and practice, including measurement rules, their scope and application for design surveying and planning</b></p> <p>3.3.1 New Rules of Measurement: NRM1, NRM2, NRM3.</p> <p>3.3.2 Civil Engineering Standard Method of Measurement, Fourth Edition (CESMM4).</p> <p>3.3.3 International Construction Measurement Standards (ICMS).</p>

## Content Area 4: Building technology

Students must be able to apply their understanding of a range of construction methods to typical applications and the technologies involved with their use. They must understand the different parts of a building and be able to identify, interpret and produce drawings of structural features and elements. Students must be aware of the various approved documents that form the building regulations and how these impact on the design of building elements, structures and services. Students must also have an understanding of the use of manufacturers' documents as required for the installation and maintenance of services within buildings.

Content area 4: Building technology	
CK4.1	<p><b>4.1 Students must understand construction methods used in residential, commercial and industrial construction contexts, and be able to discriminate between methods and select appropriately</b></p> <p>4.1.1 On-site construction methods:</p> <ul style="list-style-type: none"><li>· brick and block</li><li>· frame – portal; steel, concrete, timber</li><li>· container</li><li>· green oak</li><li>· straw bale</li><li>· cross-laminated timber (CLT)</li><li>· use of on-site robotics.</li></ul> <p>4.1.2 Off-site construction methods:</p> <ul style="list-style-type: none"><li>· structural insulated panels (SIPs)</li><li>· pre-assembled units/elements/foundations</li><li>· precast concrete sections and cladding panels</li><li>· pre-assembled structural steelwork</li><li>· steel framing systems (SFS)</li><li>· complete or modular units</li><li>· framed panels (timber, steel)</li><li>· sandwich panel systems</li><li>· concrete panels/sections (including flatpack)</li><li>· 3D printing</li><li>· 3D volumetric modules</li><li>· construction-integrated manufacturing (CIM).</li></ul> <p>4.1.3 Building renovations and refurbishment:</p> <ul style="list-style-type: none"><li>· structural – extensions, changes of use</li><li>· cosmetic upgrades</li><li>· direct replacements.</li></ul> <p>4.1.4 Sustainable energy provision within new and existing buildings.</p>

CK4.2	<p><b>4.2 Students must understand the materials, construction methods, characteristics and applications of forms of construction in order to discriminate and select forms of construction, and interpret and produce accurate drawings of these forms</b></p> <p>4.2.1 Sub-structures – foundations, basements, retaining walls, excavations.</p> <p>4.2.2 Foundations – strip (traditional, deep, narrow, wide, stepped, reinforced), raft (edge thickening, edge beams, reinforced), pad (isolated, combined, reinforced), pile (driven, cast in situ, end bearing, friction).</p> <p>4.2.3 Superstructures – frames (timber, steel, concrete, portal), roofs, floors, internal and external walls, windows and doors.</p> <p>4.2.4 Internal and external walls – types (solid masonry, cavity walls, curtain walls, infill walls, structural insulated panels (SIPs), stud), openings, insulation, damp proofing, weather tightness.</p> <p>4.2.5 External works – drainage, landscaping, parking, paving, perimeter boundaries (fences, walls).</p> <p>4.2.6 Infrastructure – roads, bridges.</p>
CK4.3	<p><b>4.3 Students must understand the purpose of buildings standards, including the benefits to the industry, regulatory bodies and consumers of such standards and their purpose in renovation and construction</b></p> <p>4.3.1 British Standards – current standards for electrical installations, gas, waste management, Building Information Modelling, fire safety.</p> <p>4.3.2 International Standards Organisation (ISO) – current standards for structures, building materials, heating, cooling and lighting, fire safety.</p> <p>4.3.3 Common Minimum Standards for Construction (CMS) – for public sector construction projects.</p>
CK4.4	<p><b>4.4 Students must have an understanding of the role of manufacturers' instructions and their purpose in ongoing maintenance and renovation of the built environment</b></p> <p>4.4.1 Types of manufacturers' instructions:</p> <ul style="list-style-type: none"> <li>· installation instruction manuals</li> <li>· operation and maintenance manuals</li> <li>· commissioning manuals.</li> </ul>

## Content Area 5: Information and data

Students must be able to apply knowledge and understanding of the key elements of information and data associated with construction activities, including the reasons why data needs to be managed and used according to regulations. They must understand where data is sourced from, including for products and specifications, and the need to manage data to maintain confidentiality.

Content area 5: Information and data	
CK5.1	<p><b>5.1 Students must have an understanding of how data is used during the design, construction, operation and decommissioning of buildings and structures</b></p> <p>5.1.1 Accuracy and precision of data. <b>(M5, M6, D4)</b></p> <p>5.1.2 Generalisation – layers of data, trends, representative data. <b>(M5, M6, D4, CS4)</b></p> <p>5.1.3 Level of information needed and metadata – data about projects, data about information flows. <b>(M5, M6, D4)</b></p> <p>5.1.4 Interoperability – exchange of data, use of data in Building Information Modelling (BIM) systems and building management systems, Construction Industry Council (CIC) BIM protocol. <b>(M5, M6, D4, CS3)</b></p>
CK5.2	<p><b>5.2 Students must understand the implications and purpose of information standards, regulation, guidance and practice for the construction industry</b></p> <p>5.2.1 Construction Operations Building Information Exchange (COBie) – facilities management, common formats and coding of data.</p> <p>5.2.2 Data management – data protection regulation, security of data, reasons for standards, compliance with guidance and practice.</p>
CK5.3	<p><b>5.3 Students must understand the characteristics and applications of the following sources of information when applied to construction activities</b></p> <p>5.3.1 Use of Land Registry data – freehold and leasehold data, land values, land and property ownership. <b>(D4)</b></p> <p>5.3.2 Data sheets – material specifications, system components, operational data, manufacturers' specifications. <b>(D4)</b></p> <p>5.3.3 Interpretation of weather and climatic data and maps. <b>(D4, CS4)</b></p> <p>5.3.4 Maps – local geological maps (desktop research), climate maps. <b>(CS4)</b></p>
CK5.4	<p><b>5.4 Students must understand the importance of data management and confidentiality</b></p> <p>5.4.1 Typical organisational procedures – information flows, shared files/systems, types of information. <b>(D4, D5)</b></p> <p>5.4.2 Legal responsibilities related to data collection and use. <b>(D4, D5)</b></p>

## Content Area 6: Digital technology

Students must be able to apply an understanding of the use of the Internet of Things within construction contexts. They must explore how digital technologies are used in the construction industry, including the benefits of using digital technologies throughout the life of a construction project, and in particular with respect to design, surveying and planning activities.

Content area 6: Digital technology	
CK6.1	<p><b>6.1 Students must demonstrate an understanding of the application of the Internet of Things (IoT) and the wider issues of the application of the IoT in the construction industry</b></p> <p>6.1.1 Data capture in a completed building. <b>(D4)</b></p> <p>6.1.2 Utilising data for manufacture and delivery, and machine-to-machine learning. <b>(D4, D5)</b></p> <p>6.1.3 Smart homes and buildings – building management systems, lighting, heating, security systems, entertainment systems. <b>(D3, D5)</b></p> <p>6.1.4 Smart applications for building and urban space management and real-time monitoring.</p> <p>6.1.5 Information interdependencies – cloud computing and storage, sensors, access to common data feeds, project management, just-in-time asset management. <b>(D4)</b></p> <p>6.1.6 Asset management – Radio-Frequency Identification (RFID) tags, embedded monitoring sensors in materials.</p>
CK6.2	<p><b>6.2 Students must understand how digital engineering techniques are used in design, surveying and planning activities</b></p> <p>6.2.1 Simulation – structural analysis, failure mode analysis and digital twins. <b>(D1, D2, CS3)</b></p> <p>6.2.2 Animation – walkthroughs, fly-throughs, visualisation of structural behaviour and simulation of system operations. <b>(M6, D1, D2, CS3)</b></p> <p>6.2.3 CAD modelling – 2D drawings, 3D models, rendered images and manipulation of images. <b>(M6, D1, D2, CS3)</b></p> <p>6.2.4 Surveying – GPS total stations, laser levelling, laser measuring devices and digital theodolites. <b>(CS4)</b></p>
CK6.3	<p><b>6.3 Students must understand the benefits of using technologies from other industries and how the construction industry is incorporating these technologies</b></p> <p>6.3.1 3D scanning – renovation/printing of houses, replacement components and visualisation of existing features. <b>(M6)</b></p> <p>6.3.2 Drones – surveying (including difficult access, dangerous conditions and thermal imaging), site security, site inspections and virtual walk-arounds.</p> <p>6.3.3 Geo surveying – laser geo-scanning.</p>

## Content Area 7: Construction mathematical techniques

Students must be able to apply an understanding of a range of mathematical, algebraic transformations and algebraic techniques and their typical applications within construction scenarios. They must understand how to carry out routine processes and how these are used to solve practical construction problems.

<b>Content area 7: Construction mathematical techniques</b>	
CK7.1	<p><b>7.1 Students must be able to select and apply mathematical and algebraic techniques correctly to solve construction problems</b></p> <p>7.1.1 Areas, volumes and perimeters of 2D and 3D shapes:</p> <ul style="list-style-type: none"> <li>· Regular shapes – rectangles, trapeziums, triangles, circles and regular polygons</li> <li>· Irregular shapes – with straight and curved edges</li> <li>· Compound shapes – combinations of whole and partial simple shapes.</li> <li>· Diameter, circumference and radius of a circle. <b>(M2, M3, M4, M7, M8)</b></li> </ul> <p>7.1.2 Pythagoras' theorem. <b>(M2, M3, M4, M7, M8)</b></p> <p>7.1.3 Trigonometric techniques: sine, cosine, tangent ratios, sine rule and cosine rule. <b>(M2, M3, M4, M7, M8)</b></p> <p>7.1.4 Triangle area rules. <b>(M2, M3, M4, M7, M8)</b></p>
CK7.2	<p><b>7.2 Students must be able to select and apply basic differentiation and integration techniques correctly and understand how calculus is used to solve practical construction problems</b></p> <p>7.2.1 Differential calculus: basic differentiation (one step) for polynomial and trigonometric functions. <b>(M2, M3, M4, M8)</b></p> <p>7.2.2 Integral calculus:</p> <ul style="list-style-type: none"> <li>· indefinite and definite integration techniques (one step) for polynomial and trigonometric functions</li> <li>· constant of integration and initial conditions. <b>(M2, M3, M4, M8)</b></li> </ul> <p>7.2.3 Numerical integration: Simpson's Rule, Mid-Ordinate Rule, Trapezoidal Rule. <b>(M2, M3, M4, M8)</b></p>
CK7.3	<p><b>7.3 Students must be able to use statistical methods to analyse grouped, ungrouped, continuous and discrete sets of data, and understand how these are used to solve practical construction problems</b></p> <p>7.3.1 Averages and central tendency: mean, median and mode. <b>(M2, M3, M4, M5, M6, M8)</b></p> <p>7.3.2 Dispersion: range, standard deviation. <b>(M2, M3, M4, M5, M6, M8)</b></p>

## Content Area 8: Design

Students must be able to apply knowledge and understanding of factors that affect the design process, and the benefits of good design. They must also demonstrate an understanding of these principles with respect to the buildability of a construction project, roles and responsibilities of members of a construction team and how they interact. They will also develop an understanding of how to interpret, apply and use a range of graphic detailing techniques.

Content area 8: Design	
CK8.1	<p><b>8.1 Students must understand the benefits of good design, including delivering within budget, to product performance</b></p> <p>8.1.1 Design to make best use of efficient heating, keeping heat inside the building.</p> <p>8.1.2 How good design and materials use leads to better saleability and general uplift to the area.</p> <p>8.1.3 How simple, affordable improvement in design gives a better quality of life.</p> <p>8.1.4 Efficient use of all light in the design to improve quality of life.</p> <p>8.1.5 Use of good design to improve productivity and wellbeing of workers.</p> <p>8.1.6 How good design can deliver project outcomes within budget.</p> <p>8.1.7 Layout and efficient use of space.</p>
CK8.2	<p><b>8.2 Students must understand the principles of design for a construction project</b></p> <p>8.2.1 Aesthetics of design:</p> <ul style="list-style-type: none"> <li>· use of design features to provide symmetry</li> <li>· use of repeated elements</li> <li>· proportion of design features</li> <li>· use of contrasting materials to provide emphasis</li> <li>· use of colour and texture</li> <li>· integration of elements to provide continuity of design. <b>(CS3)</b></li> </ul> <p>8.2.2 Buildability:</p> <ul style="list-style-type: none"> <li>· ability to construct within a short timescale</li> <li>· provision and integration of services</li> <li>· identification of clashes and solutions</li> <li>· opportunities to incorporate modern methods of construction. <b>(CS3)</b></li> </ul> <p>8.2.3 Spatial requirements of buildings:</p> <ul style="list-style-type: none"> <li>· provision of space for services</li> <li>· provision of space for access. <b>(CS3)</b></li> </ul> <p>8.2.4 Safety:</p> <ul style="list-style-type: none"> <li>· allowing safe construction methods</li> <li>· safety requirements for the client and end user. <b>(CS3)</b></li> </ul>

CK8.3	<p><b>8.3 Students must understand the design process for construction projects, from conception to completion</b></p> <p>8.3.1 Functional factors:</p> <ul style="list-style-type: none"> <li>· how the building operates within its defined use</li> <li>· the project's spatial requirements – building size, layout, circulation space, number of floors, number and use of rooms</li> <li>· future-proofing of designs: extension potential to meet residential needs and business expansion, flexibility and remodelling potential</li> <li>· external and internal aesthetics</li> <li>· types and use of materials</li> <li>· sustainability, energy efficiency, alternate types of energy sources and sustainable technologies</li> <li>· target market sector – age demographic of the building user(s), needs of different building users, corporate image and branding requirements</li> <li>· security requirements for the building and client operations life expectancy – design life of buildings. <b>(CS3)</b></li> </ul> <p>8.3.2 Site information factors:</p> <ul style="list-style-type: none"> <li>· site features – location, size, configuration, orientation, access, topography, flood risk</li> <li>· borehole report used to provide information on geotechnical and ground conditions</li> <li>· building services availability</li> <li>· existing buildings and structures</li> <li>· neighbouring structures and the need for temporary and permanent support</li> <li>· restrictions – trees and tree preservation orders, rights of way/wayleaves and underground transport. <b>(E3, CS3)</b></li> </ul> <p>8.3.3 Planning factors:</p> <ul style="list-style-type: none"> <li>· planning consent/approval</li> <li>· local plan requirements</li> <li>· being sympathetic to the local environment</li> <li>· planning objections and pressure groups</li> <li>· listed building consent</li> <li>· environmental factors: protection of green belt land, conservation areas, Areas of Outstanding Natural Beauty (AONBs), Sites of Special Scientific Interest (SSSIs) and tree preservation orders (TPOs). <b>(E3, CS3)</b></li> </ul> <p>8.3.4 Statutory constraints and their requirements and impacts on inclusivity:</p> <ul style="list-style-type: none"> <li>· Equality Act</li> <li>· Access to and use of buildings – Approved Document M</li> <li>· restrictive covenants on land and property. <b>(CS3)</b></li> </ul>
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	<p>8.3.5 Indoor Environmental Quality (IEQ), covering:</p> <ul style="list-style-type: none"> <li>· indoor air quality</li> <li>· thermal comfort</li> <li>· lighting</li> <li>· acoustics. <b>(CS3)</b></li> </ul> <p>8.3.6 Social constraints:</p> <ul style="list-style-type: none"> <li>· neighbours' rights – shared access, not being overlooked</li> <li>· local community objections</li> <li>· green space requirements</li> <li>· environmental requirements</li> <li>· mixed and balanced development. <b>(CS3)</b></li> </ul> <p>8.3.7 Project budget and economic constraints:</p> <ul style="list-style-type: none"> <li>· cost/benefit analysis</li> <li>· local land prices</li> <li>· available funds</li> <li>· sources of additional funding for business premises – grants, government incentives</li> <li>· home ownership and funding – shared-ownership schemes and government incentives for developers and buyers</li> <li>· funding of infrastructure projects - local authority, government, private investment</li> <li>· life cycle costs. <b>(D1, D2, CS3)</b></li> </ul> <p>8.3.8 Stages of the design process for construction projects:</p> <ul style="list-style-type: none"> <li>· definition of the project</li> <li>· establish client needs</li> <li>· feasibility study</li> <li>· concept designs</li> <li>· detail design</li> <li>· production information</li> </ul> <p>8.3.9 ongoing design development.</p>
CK8.4	<p><b>8.4 Students must understand the principles and benefits associated with a life cycle assessment (LCA) for construction materials and components</b></p> <p>8.4.1 Stages of life cycle assessment in construction:</p> <ul style="list-style-type: none"> <li>· raw material or recycled material supply</li> <li>· manufacture of construction products</li> <li>· the construction process stage</li> <li>· occupation, use and maintenance stage</li> <li>· demolition</li> <li>· material disposal or recycling.</li> </ul>

CK8.5	<p><b>8.5 Students must understand applications of manual and computer-aided (CAD) techniques for graphical detailing, and be able to produce construction drawings, charts and diagrams</b></p> <p>8.5.1 Manual and CAD drawing techniques, application and use, including:</p> <ul style="list-style-type: none"> <li>· drawing lines and shapes – regular and irregular shapes, line conventions</li> <li>· drawing to a scale</li> <li>· lettering and dimensioning</li> <li>· 2D drawings, including the use of orthographic projection, schematic plans and layout diagrams, elevations, site layout plans and cross-sections</li> <li>· 3D drawings, including the use of isometric projection, single and two-point perspective. <b>(M1, M9)</b></li> </ul> <p>8.5.2 CAD techniques to produce 2D and 3D drawings:</p> <ul style="list-style-type: none"> <li>· use of set-up, drawing, editing and zoom commands</li> <li>· setting up floor and external levels</li> <li>· drawing with composite elements</li> <li>· inserting standard components</li> <li>· layers in drawing production</li> <li>· Basic 3D virtual building models, including producing camera views and rendered images. <b>(M1, M9, D1, D2, D3, D5)</b></li> </ul> <p>8.5.3 Graphic conventions and standard symbols in accordance with British and international standards for construction, design, surveying, building services and planning detail, including:</p> <ul style="list-style-type: none"> <li>· electrical and plumbing – basic symbols used in domestic, industrial and commercial installations</li> <li>· ventilation – basic symbols used in commercial and industrial installations</li> <li>· construction materials – basic symbols used in industrial, domestic and commercial installations</li> <li>· construction components – basic symbols used in domestic and commercial installations</li> <li>· civil engineering – basic symbols used in domestic and commercial installations.</li> </ul>
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## Content Area 9: Construction and the built environment industry

Students must be able to apply knowledge and understanding of the structure of the construction industry and the activities completed by different sectors. They must also demonstrate an understanding of the benefits of construction projects on both local and national levels. Students must understand the practices and processes involved with developing documentation for quantification and costing activities. They will also be able to complete calculations as part of costing activities and understand the roles of construction professionals.

<b>Content area 9: Construction and the built environment industry</b>	
CK9.1	<p><b>9.1 Students must understand the structure of the construction industry and the activities carried out by different sectors</b></p> <p>9.1.1 Types of activity undertaken by sectors in the construction industry:</p> <ul style="list-style-type: none"> <li>· sectors – infrastructure, industrial, residential, commercial, health, education, leisure and recreation</li> <li>· design and construction of buildings, structures and infrastructure</li> <li>· refurbishment of existing buildings</li> <li>· retrofit of existing buildings for energy efficiency</li> <li>· repairs and maintenance of buildings</li> <li>· estates and facilities management</li> <li>· demolition of buildings and infrastructure.</li> </ul>
CK9.2	<p><b>9.2 Students will understand how the construction industry serves the economy as a whole</b></p> <p>9.2.1 The wealth generated by property and land development:</p> <ul style="list-style-type: none"> <li>· benefits to the UK economy, built environment and local communities</li> <li>· regeneration of inner-city areas.</li> </ul> <p>9.2.2 The contribution to infrastructure:</p> <ul style="list-style-type: none"> <li>· transport networks</li> <li>· provision of services – gas, electricity, water and communications technology</li> <li>· water management – drainage, sewer systems, flood defences</li> <li>· renewable energy projects.</li> </ul> <p>9.2.3 The contribution to the community:</p> <ul style="list-style-type: none"> <li>· housing – private, social, shared ownership</li> <li>· employment – in construction and the wider community</li> <li>· transport – roads, railways, footpaths, cycle routes, buses</li> <li>· security</li> <li>· industrial and commercial developments.</li> <li>· health - hospitals, health centres</li> <li>· education - schools, colleges, academies</li> <li>· leisure/recreation - parks, communities centres.</li> </ul>

	<p>9.2.4 The benefits to the local community of the redevelopment of brownfield sites:</p> <ul style="list-style-type: none"> <li>· removal of chemical or toxic contamination</li> <li>· reuse of waste land</li> <li>· economic uplift in the area</li> <li>· environmental protection of local habitats and resources.</li> <li>· improvement of safety and security, removal of anti-social behaviour and general blight.</li> </ul>
CK9.3	<p><b>9.3 Students will understand the principles of the integration of the supply chain through partnering and collaborative practices</b></p> <p>9.3.1 Inventory management and supply chain components:</p> <ul style="list-style-type: none"> <li>· logistics activities in the supply chain – just in time, materials handling, production, inventory management, transportation and security of supplies</li> <li>· monitoring and controlling inventory – just-in-time deliveries and supply and Kanban systems in prefabrication and on-site construction.</li> </ul> <p>9.3.2 Integrating supply chains:</p> <ul style="list-style-type: none"> <li>· sharing requirements and the need for goods, services and quality standards</li> <li>· integrating computer systems – common data and communication standards, electronic data interchange (EDI)</li> <li>· specifying and agreeing responsibilities of individual businesses.</li> </ul>
CK9.4	<p><b>9.4 Students must understand the principles and application of quantification and costing</b></p> <p>9.4.1 Application of standards in the production of quantities, including:</p> <ul style="list-style-type: none"> <li>· descriptions for bills of quantities</li> <li>· variations</li> <li>· interim payments</li> <li>· final account work</li> <li>· claims and disputes</li> <li>· cost-reporting guidance notes. <b>(E2, E4, M2, M4, D4)</b></li> </ul> <p>9.4.2 Descriptions and quantities used when producing tender documents:</p> <ul style="list-style-type: none"> <li>· compilation of descriptions for works.</li> </ul>

CK9.5	<p><b>9.5 Students must understand the principles of financial controls and apply these to construction situations</b></p> <p>9.5.1 Calculation of all-in rates for materials, labour and plant are completed, including:</p> <ul style="list-style-type: none"> <li>· material costs – calculation of material quantities</li> <li>· cost of construction works, based on unit costs of materials</li> <li>· labour rates – calculation of all-in rates for craft workers (skilled, unskilled, gang rates)</li> <li>· application of labour costs in unit rates and hourly rates</li> <li>· plant rates – calculation of fixed and operating costs, units and hourly rates</li> <li>· calculation of unit rates and hourly rates – substructure, superstructure, first fix, second fix</li> <li>· completion of documentation. <b>(M9)</b></li> </ul> <p>9.5.2 Use of rate tables, standard price books, historical rates. <b>(M9)</b></p>
CK9.6	<p><b>9.6 Students must be able to understand the roles, responsibilities and interactions of construction and trade professionals, including the stages where they are involved in the design of a construction project</b></p> <p>9.6.1 Construction professionals:</p> <ul style="list-style-type: none"> <li>· contractors</li> <li>· land surveyors</li> <li>· quantity surveyors (main contractors and professional)</li> <li>· hazardous materials surveyors</li> <li>· structural engineers</li> <li>· heating engineers</li> <li>· electrical engineers</li> <li>· civil engineers</li> <li>· building services engineers</li> <li>· architects</li> <li>· project managers. <b>(CS2)</b></li> </ul> <p>9.6.2 Trade professionals:</p> <ul style="list-style-type: none"> <li>· carpenters</li> <li>· joiners</li> <li>· painters and decorators</li> <li>· bricklayers</li> <li>· ground workers</li> <li>· plasterers</li> <li>· electricians</li> <li>· plumbers</li> <li>· roofers</li> <li>· HVAC technicians. <b>(CS2)</b></li> </ul>

CK9.7	<p><b>9.7 Students will understand the role development and Continuing Professional Development (CPD) have in developing the knowledge and skills of those working in the construction sector, and the organisations that may provide it</b></p> <p>9.7.1 The role of development and CPD to further careers and keep up to date with the current standards and practices:</p> <ul style="list-style-type: none"> <li>· types of development – apprenticeships, degree apprenticeships, graduate training programmes, higher technical qualifications</li> <li>· types of CPD – in-house training, formal training, updating of qualifications and skills, gaining experience, becoming chartered, progression qualifications, self-learning.</li> </ul>
CK9.8	<p><b>9.8 Students must understand how Building Information Modelling (BIM), the Plan of Work (PoW), the Digital Plan of Work (DPoW), Exchange Information Requirements (EIR) and the Common Data Environment (CDE) are used in construction projects and how the exchange of information can affect project delivery</b></p> <p>9.8.1 The stages of a Plan of Work and its application to construction projects:</p> <ol style="list-style-type: none"> <li>1. Preparation and brief</li> <li>2. Concept design</li> <li>3. Spatial considerations</li> <li>4. Technical design</li> <li>5. Manufacturing and construction</li> <li>6. Handover</li> <li>7. Use</li> </ol> <p><b>(D1, D2, D3, E6, E4, CS1)</b></p> <p>9.8.2 The characteristics and protocols associated with BIM and the implementation of BIM within the RIBA DPoW:</p> <ul style="list-style-type: none"> <li>· enables digital technology design and communication</li> <li>· embeds key product and asset data in all project stages</li> <li>· manages information throughout the project life cycle, using three-dimensional (3D) computer modelling</li> <li>· provides an information repository for digital data project information throughout a design and construction project, with the capability to manipulate and produce information and support information sharing</li> <li>· produces unified information output for the client at handover</li> <li>· provides a model of the building through the life cycle that can be updated</li> <li>· the model is used as part of the decommissioning and recycling of the building at the end of its life. <b>(D1, D2, D5, D3, E1, E2)</b></li> </ul> <p>9.8.3 Modelling and analysis – digital data to assist structural analysis, BIM modelling, old information used to support new plans, visual modelling. <b>(D1, D4, CS3)</b></p> <p>9.8.4 The integration of manuals and information within a Building Information Modelling (BIM) environment.</p>

	<p>9.8.5 The characteristics and measures associated with a Common Data Environment (CDE) and how CDE supports the operation of a BIM-led design and construction project:</p> <ul style="list-style-type: none"> <li>· a construction project's CDE is up to date throughout the life cycle of the building</li> <li>· the content is suitable, accurate and accessible to all.</li> </ul> <p><b>(D1, D2, D5, D3, E1, E2, CS3, CS2)</b></p> <p>9.8.6 The characteristics and applications of Employer's Information Requirements (EIR) as part of a BIM Execution Plan, including the use of EIR as part of the appointment and tender documents, and the scope of information that is needed:</p> <ul style="list-style-type: none"> <li>· Who is sharing information?</li> <li>· What information is needed by stakeholders?</li> <li>· When is information needed by stakeholders?</li> <li>· What is the purpose of the information?</li> <li>· What are the effects on project outcome and delivery?</li> </ul> <p><b>(D1, D2, D5, D3, E1, E2, CS2)</b></p>
CK9.9	<p><b>9.9 Students must understand what PESTLE analysis is and be able to apply current examples of PESTLE factors to situations that may impact on the construction industry</b></p> <p>9.9.1 Political: these factors determine the extent to which a government may influence the economy or a certain industry.</p> <ul style="list-style-type: none"> <li>· Economic: these factors are determinants of an economy's performance that directly impact on a company and have resonating long-term effects.</li> <li>· Social: these factors scrutinise the social environment of the market, and gauge determinants such as cultural trends, demographics and population analytics.</li> <li>· Technological: these factors pertain to innovations in technology that may affect the operations of the industry and the market favourably or unfavourably.</li> <li>· Legal: the implications of legislation to the project, including contract law, building regulations, building control, HSWA, civil law.</li> <li>· Environmental: these factors include all those that influence or are determined by the surrounding environment. <b>(CS3)</b></li> </ul>

## Content Area 10: Sustainability

Students will be able to show and apply knowledge and understanding of sustainability as applied to construction projects. This will include the considerations of materials, methods and technologies that can be used to improve sustainability and reduce the environmental impact of a project. They will be able to apply their understanding of the principles of conservation and heritage that apply to given construction contexts.

Content area 10: Sustainability	
CK10.1	<p><b>10.1 Students will understand the importance of sustainability when planning and delivering a construction project</b></p> <p>10.1.1 Minimisation of the impact of construction activities.</p> <p>10.1.2 Use of sustainable construction methods and materials.</p> <p>10.1.3 Use of construction site practices that minimise the effect on the natural and physical environment.</p> <p>10.1.4 Reduced reliance on finite fuels and natural resources.</p> <p>10.1.5 Designing for future effects of climate change.</p> <p>10.1.6 The Green Guide to Specification.</p>
CK10.2	<p><b>10.2 Students must understand the impact of sustainable solutions on social, environmental, economic and human factors, and be able to apply sustainable solutions for design, surveying and planning of construction</b></p> <p>10.2.1 Types of sustainable solution:</p> <ul style="list-style-type: none"> <li>· straw bale construction</li> <li>· timber framed/panelled construction</li> <li>· modular and pre-fabrication construction techniques</li> <li>· use of thermal mass within buildings to absorb and emit heat</li> <li>· use of low embodied energy materials</li> <li>· insulation</li> <li>· water saving solutions</li> <li>· use of Sustainable Urban Drainage Systems (SUDS)</li> <li>· energy-efficient heating, ventilation and lighting systems</li> <li>· glazing – smart glass, double/triple glazing, low-emissivity glass</li> <li>· use of materials to enable easier recycling at the end of their life.</li> </ul>



	<p>10.2.2 How sustainable materials are used in sustainable solutions:</p> <ul style="list-style-type: none"> <li>· timber-based products – cedar boarding, shingles, recycled particleboard sheets, engineered eco joists, engineered timber joists, timber framing (softwood and hardwood) and structural insulated panels (SIPs)</li> <li>· roofing materials – thatch and reconstituted slates</li> <li>· insulation materials – recycled glass mineral wool, sheep’s wool insulation, hemp and flax</li> <li>· recycled building materials – crushed hardcore from demolition, recycled bricks, recycled slates.</li> </ul> <p>10.2.3 Embodied energy:</p> <ul style="list-style-type: none"> <li>· Embodied energy of construction materials</li> <li>· Factors that contribute to embodied energy – extraction of resources, processing, assembling, transportation, construction, maintenance and repair, demolition, disposal.</li> </ul>
CK10.3	<p><b>10.3 Students must understand obligations under environmental legislation</b></p> <p>10.3.1 Current environmental law that concerns the protection of the environment in the United Kingdom with respect to:</p> <ul style="list-style-type: none"> <li>· climate change</li> <li>· biodiversity</li> <li>· the Clean Air Act</li> <li>· the Water Act</li> <li>· the Wildlife and Countryside Act.</li> </ul> <p>10.3.2 Ground contamination:</p> <ul style="list-style-type: none"> <li>· surveying of potentially contaminated land including site surveys and desk based surveys</li> <li>· types of contaminant, including radioactive, toxic and biological (including non-native plant species)</li> <li>· safe disposal of waste material, including radioactive, toxic and biological (including non-native plant species)</li> <li>· treatment of contaminated land for radioactive, toxic and biological contaminates</li> <li>· containment of contaminates. <b>(CS4)</b></li> </ul>

CK10.4	<p><b>10.4 Students must understand environmental policies, initiatives and performance measures, and how they impact on design and construction</b></p> <p>10.4.1 Conservation of fuel and power – Approved Document L.</p> <p>10.4.2 Environmental and sustainability assessment tools:</p> <ul style="list-style-type: none"> <li>· Building Research Establishment Environmental Assessment Method (BREEAM).</li> <li>· BREEAM Infrastructure (formerly Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL))</li> <li>· Home Quality Mark</li> <li>· National Space Standards for Dwellings.</li> </ul> <p>10.4.3 Government subsidies for using environmental technologies.</p> <p>10.4.4 Environmental Performance Certificate (EPC) to rate a building on its energy usage and carbon footprint.</p>
CK10.5	<p><b>10.5 Students must understand the principles of heritage and conservation within a construction environment</b></p> <p>10.5.1 Restrictions associated with listed and historical buildings:</p> <ul style="list-style-type: none"> <li>· listed building grading – Grade I, Grade II* and Grade II</li> <li>· permissions for buildings to be demolished, extended or altered</li> <li>· notification of work to a listed building that involves any element of demolition.</li> </ul> <p>10.5.2 Legislation and guidance relating to listed buildings and heritage sites:</p> <ul style="list-style-type: none"> <li>· Planning (Listed Buildings and Conservation Areas) Act</li> <li>· Heritage Protection Bill.</li> </ul>
CK10.6	<p><b>10.6 Students must understand the principles of ‘lean construction’ and how it applies to the construction industry</b></p> <p>10.6.1 Aims of lean construction:</p> <ul style="list-style-type: none"> <li>· eliminating waste and errors through reduction, recycling and repurposing</li> <li>· improving work planning and forward scheduling</li> <li>· identifying the processes that deliver best value</li> <li>· eliminating activities that do not add value</li> <li>· ensuring the working environment is clean, safe and efficient</li> <li>· continuous improvement. <b>(CS3)</b></li> </ul>

CK10.7	<p><b>10.7 Students must understand waste management, including sources of waste and types of materials that require specific actions, and the related measures put in place by construction organisations</b></p> <p>10.7.1 Plan safe transportation and disposal of waste:</p> <ul style="list-style-type: none"> <li>· the categorisation of waste materials for general disposal</li> <li>· specialist disposal of hazardous waste</li> <li>· using licensed disposal contractors</li> <li>· incineration for specialist disposal</li> <li>· use of Environment Agency registered waste carriers. <b>(CS3)</b></li> </ul> <p>10.7.2 Plan methods to minimise pollutants associated with construction-related activities:</p> <ul style="list-style-type: none"> <li>· how to reduce the noise from construction operations (use of silencers, maintenance of machinery)</li> <li>· reduction of emissions from construction traffic, plant and machinery (use of modern fuel-efficient vehicles and equipment, regular maintenance, servicing, use of locally sourced materials, buying in bulk, ordering a variety of materials from one supplier to cut travel distances and the number of journeys to the site)</li> <li>· reduction of high carbon emissions created during the manufacture of high energy materials.</li> <li>· reduction of dust from excavation and demolition work (damping down, road sweeping, use of dust suppression equipment, wheel cleaning)</li> <li>· reduction of land contamination, waste treatment and correct waste disposal (general waste disposal, specialist waste disposal handling by trained and licensed contractors, site drainage damage minimisation by washing out cement plant and equipment, use of settlement tanks to filter debris, minimisation of fuel and oil spillages by use of bunded tanks, bund walls and absorbent mats). <b>(CS3)</b></li> </ul>
CK10.8	<p><b>10.8 Students must understand the advantages of alternative methods of energy production and the impact of energy use</b></p> <p>10.8.1 Ground source – ground source heat pump (horizontal and vertical).</p> <p>10.8.2 Air source – air source heat pump (indoor heat exchanger, outdoor heat exchanger, air to air, air to water).</p> <p>10.8.3 Wind – micro wind generator (horizontal axis, vertical axis).</p> <p>10.8.4 Solar – solar photovoltaic (PV) panels, solar panels (thermal).</p> <p>10.8.5 Combined heat and power.</p> <p>10.8.6 Biomass fuel heating systems.</p>

## Content Area 11: Relationship management

Students will demonstrate knowledge and understanding of the various stakeholders with interests in construction projects, the need to collaborate and ways in which collaboration can be encouraged. Students must understand key principles of customer service and teamwork. They will also understand the importance of equality, diversity, negotiation and conflict management techniques. They will gain an understanding of methods of communication, including social media, in addition to the rights of both employers and employees, and ethical behaviours.

Content area 11: Relationship management	
CK11.1	<p><b>11.1 Students must understand roles, expectations and interrelationships of different stakeholders throughout the construction project delivery</b></p> <p>11.1.1 Expectations and interrelationships of different stakeholders during stages of a construction project:</p> <ul style="list-style-type: none"> <li>· during the start of a project</li> <li>· during the design stage</li> <li>· during the construction phase</li> <li>· at the handover of the project</li> <li>· once the project is completed and in use. <b>(E1, CS2, CS1)</b></li> </ul>
CK11.2	<p><b>11.2 Students must understand the importance of a collaborative approach during a project, and how this is applied in practice at different stages of a project</b></p> <p>11.2.1 Collaborative approaches during project delivery:</p> <ul style="list-style-type: none"> <li>· delivery – meeting deadlines and specifications</li> <li>· reporting – awareness of progress and issues</li> <li>· presenting information and ideas to technical and non-technical audiences to convey different project information</li> <li>· summarising information – requesting information and recording for later use</li> <li>· synthesising information – using more than one source to interpret and respond to different situations</li> <li>· crowdsourcing - collaborative working, sharing ideas, problem solving, design thinking. <b>(E2, E4, E5, CS2, CS3)</b></li> </ul>

CK11.3	<p><b>11.3 Students must understand the principles and importance of customer service</b></p> <p>11.3.1 Importance, implications and benefits of building good customer relationships:</p> <ul style="list-style-type: none"> <li>· enhanced reputation of business</li> <li>· repeat business</li> <li>· customer confidence in business</li> <li>· job satisfaction for employees. <b>(CS1)</b></li> </ul> <p>11.3.2 Principles of customer service:</p> <ul style="list-style-type: none"> <li>· good communication, meeting agreed timescales, timely customer responses and monitoring of progress</li> <li>· good product knowledge – building trust and meeting expectations. <b>(CS1)</b></li> </ul>
CK11.4	<p><b>11.4 Students must understand the effects of team dynamics on a team's success and the importance of teamwork to team and project performance</b></p> <p>11.4.1 Positive effects of good teamwork:</p> <ul style="list-style-type: none"> <li>· improved efficiency and performance</li> <li>· less reliance on managers to make decisions in response to changing circumstances</li> <li>· high levels of staff morale</li> <li>· improved innovation and willingness to suggest new ideas</li> <li>· complementary skills sets</li> <li>· mutual accountability. <b>(E1, CS2)</b></li> </ul>
CK11.5	<p><b>11.5 Students must understand team dynamics, the characteristics of an effective team, the qualities and expectations of a team member and how these qualities are demonstrated</b></p> <p>11.5.1 Qualities and characteristics of an effective team and team members:</p> <ul style="list-style-type: none"> <li>· effective communication between team members</li> <li>· increased morale</li> <li>· knowledge of organisation, product and service</li> <li>· organisation in job roles – clear leadership, defining job roles and responsibilities</li> <li>· adaptable/flexible approach</li> <li>· working to team members' strengths and weaknesses. <b>(E2, E6, CS2)</b></li> </ul>
CK11.6	<p><b>11.6 Students must understand the importance of equality, diversity and representation, including related legislation</b></p> <p>11.6.1 Legislation: Equality Act, Employment Rights Act, Human Rights Act.</p> <p>11.6.2 Trade unions – right to representation, right to membership.</p>

CK11.7	<p><b>11.7 Students must understand negotiation techniques and how they are used when taking part in discussions with clients, contractors and other relevant stakeholders</b></p> <p>11.7.1 Negotiation techniques:</p> <ul style="list-style-type: none"> <li>· win-win</li> <li>· lose-lose</li> <li>· I win, you lose</li> <li>· I win/lose some, you win/lose some</li> <li>· I lose, you win. <b>(E6, CS1)</b></li> </ul>
CK11.8	<p><b>11.8 Students must understand conflict management techniques</b></p> <p>11.8.1 Conflict resolution techniques:</p> <ul style="list-style-type: none"> <li>· collaborating or problem solving</li> <li>· compromising</li> <li>· smoothing</li> <li>· forcing</li> <li>· withdrawing or avoiding</li> <li>· mediation. <b>(CS1, CS2, CS3)</b></li> </ul>
CK11.9	<p><b>11.9 Students must understand methods and styles of communication and the suitability of these for different situations that may arise throughout a construction project</b></p> <p>11.9.1 Formal and informal styles of communication to convey technical information to different audiences:</p> <ul style="list-style-type: none"> <li>· discussions with the client</li> <li>· communicating information to stakeholders – local authority, general public, planning notices and applications. <b>(E1, E2, CS1)</b></li> </ul> <p>11.9.2 Methods of verbal and non-verbal communication:</p> <ul style="list-style-type: none"> <li>· verbal – pitch and tone of voice, open and closed questions, using the telephone, presentations</li> <li>· non-verbal – written, sign and body language, listening skills. <b>(E1, E2, E4, E6, CS1)</b></li> </ul> <p>11.9.3 Communication skills and how they can be applied in construction situations, including face-to-face meetings and conversations, discussions, presentations, email or other electronic media, telephone, written, drawn information. <b>(E1, E2, E4, E6, CS1, CS2)</b></p>

CK11.10	<p><b>11.10 Students must understand employment rights and the responsibilities of the employer and employee</b></p> <p>11.10.1 Employment rights available to all employees, including:</p> <ul style="list-style-type: none"> <li>· national minimum wage, national living wage, illegal deductions, timing of payment, pension</li> <li>· health and safety</li> <li>· time off – holiday entitlements (full- and part-time employees), time off for trade union duties, weekly and daily rest breaks</li> <li>· access to a trade union representative in the event of a grievance</li> <li>· not being harassed or discriminated against</li> <li>· maternity leave, paternity leave and unpaid parental leave.</li> </ul> <p>11.10.2 Responsibilities of employers and employees:</p> <ul style="list-style-type: none"> <li>· employer to an employee – providing work, pay and health, safety and welfare compliance</li> <li>· employee to an employer – obeying reasonable instructions/orders, not stealing, complying with health and safety requirements.</li> </ul>
CK11.10	<p><b>11.11 Students must understand ethics and ethical behaviour as applied to working in the construction industry</b></p> <p>11.11.1 Ethics and ethical behaviours: honesty, fairness and equality.</p>
CK11.11	<p><b>11.12 Students will understand how using sources of information, including social networking, contributes to knowledge sharing</b></p> <p>11.12.1 Use of information, including web-based sources for knowledge sharing with stakeholders:</p> <ul style="list-style-type: none"> <li>· collaborating on ideas using social networking</li> <li>· promoting products and services through social media and advertisements</li> <li>· gathering customer feedback. <b>(CS2)</b></li> </ul>

## Content Area 12: Commercial business

Students must be able to apply knowledge and understanding of the different sizes of business that carry out design, surveying and planning activities in the construction sector. They will develop an understanding of the objectives and values of businesses, and approaches that can be used to measure the success of construction projects in varying contexts and situations.

<b>Content area 12: Commercial business</b>	
CK12.1	<p><b>12.1 Students must understand types of business structure and the roles each may play in a construction project</b></p> <p>12.1.1 Types of business structure:</p> <ul style="list-style-type: none"> <li>· small and medium enterprises (SMEs)</li> <li>· private – including sole partnerships, partnerships, limited liability, corporations</li> <li>· not-for-profit: community interest companies (CIC), public organisations.</li> </ul>
CK12.2	<p><b>12.2 Students must understand business objectives of organisations in the construction industry</b></p> <p>12.2.1 Financial business objectives:</p> <ul style="list-style-type: none"> <li>· private organisations – profitability, growth, market leadership</li> <li>· not-for profit-organisations – alleviating poverty, cost control, value for money. <b>(M6, M9)</b></li> </ul> <p>12.2.2 Social business objectives:</p> <ul style="list-style-type: none"> <li>· private organisations – provision of employment</li> <li>· not-for profit-organisations – provision of education, provision of housing, provision of healthcare, service provision, service quality, meeting government standards. <b>(M9)</b></li> </ul>
CK12.3	<p><b>12.3 Students must understand the need for business values and ethical and transparent business practices</b></p> <p>12.3.1 Environmental values: Fair Trade, Forestry Stewardship Council (FSC).</p> <p>12.3.2 Company code of conduct.</p>
CK12.4	<p><b>12.4 Students must understand the principles of corporate social responsibility</b></p> <p>12.4.1 Approaches to corporate social responsibility (CSR):</p> <ul style="list-style-type: none"> <li>· incorporating sustainable development into a company's business model</li> <li>· positive impacts on social, economic and environmental factors</li> <li>· use of local resources – local trades, local suppliers and locally produced materials</li> <li>· community design – community-led designs, inclusive design.</li> </ul>



CK12.5	<p><b>12.5 Students must understand the role of innovation and entrepreneurship within the construction industry</b></p> <p>12.5.1 Innovation and entrepreneurship:</p> <ul style="list-style-type: none"> <li>· product or service development</li> <li>· successfully exploiting a new idea</li> <li>· adding value to buildings and structures to differentiate the project from the competitors</li> <li>· having a vision for opportunities to develop projects.</li> </ul>
CK12.6	<p><b>12.6 Students must understand how businesses measure success</b></p> <p>12.6.1 Key performance indicators (KPIs), including their use with target setting:</p> <ul style="list-style-type: none"> <li>· input KPIs – purchases made, resources, funding for training</li> <li>· process KPIs – efficiency or productivity, average daily rate, production time</li> <li>· output KPIs – gross/net profit margin, operating margin, return on investment. <b>(CS1)</b></li> </ul> <p>12.6.2 The characteristics of benchmarking and target setting as a measure of success, including:</p> <ul style="list-style-type: none"> <li>· meeting/exceeding client expectations</li> <li>· clearly defining the service level agreement (SLA)</li> <li>· setting the performance standard required. <b>(CS1)</b></li> </ul>

## Content Area 13: Project management

Students will be able to demonstrate and apply knowledge and understanding of successful project management, including aspects linked to quality and risk management. They will understand activities that are completed during the four stages of a project life cycle, and how project management tools can be used to plan and monitor progress of a project. They will demonstrate their understanding of the tendering process and documentation that forms tenders.

Content area 13: Project management	
CK13.1	<p><b>13.1 Students must understand the principles of project management</b></p> <p>13.1.1 The common roles and responsibilities of the client, community, end user, project teams and the project manager.</p> <p>13.1.2 Principles of project management – goals, objectives, milestones.</p>
CK13.2	<p><b>13.2 Students must have an understanding of the importance of quality management techniques used in the construction industry</b></p> <p>13.2.1 Quality management techniques:</p> <ul style="list-style-type: none"> <li>• quality assurance and control</li> <li>• total quality management</li> <li>• benchmarking</li> <li>• continuous improvement process</li> <li>• value engineering.</li> </ul>
CK13.3	<p><b>13.3 Students must understand approaches to project management throughout the whole life cycle and work stages of a construction project</b></p> <p>13.3.1 Stages of the project management life cycle:</p> <ul style="list-style-type: none"> <li>• initiation – identification and justification of project need, assessing the size, scope and feasibility of the project</li> <li>• planning – establishing project requirements (costs, schedule, deliverables, delivery dates), resources, quality, communication planning and risk analysis</li> <li>• execution – status and tracking, quality, KPIs, forecasting</li> <li>• performance and control – objectives, quality deliverables, cost tracking</li> <li>• closure – snagging, reporting, lessons learned. <b>(CS3)</b></li> </ul> <p>13.3.2 Interpretation and production of project management tools and documentation; planning and management tools – Gantt charts, bar charts, critical path analysis, line of balance and suitable planning software. <b>(CS3)</b></p>

CK13.4	<p><b>13.4 Students must understand the management of the procurement process</b></p> <p>13.4.1 The characteristics of the following procurement routes:</p> <ul style="list-style-type: none"> <li>· traditional/conventional</li> <li>· design and build</li> <li>· management</li> <li>· integrated.</li> </ul> <p>13.4.2 Common methods of tendering and how to create texts for different purposes and audiences:</p> <ul style="list-style-type: none"> <li>· methods of tendering relevant to the scale, size and value of the construction works</li> <li>· types of work tendered for (building, civil engineering, surveying and building services work). <b>(E3, E5)</b></li> </ul> <p>13.4.3 Documentation required for procurement and tendering, and how to create texts for different purposes and audiences, including:</p> <ul style="list-style-type: none"> <li>· drawings, such as site layout plans</li> <li>· schedules – schedules of work, activity schedules</li> <li>· specifications</li> <li>· bills of quantities</li> <li>· method statements. <b>(E3, E5, CS1)</b></li> </ul>
CK13.5	<p><b>13.5 Students must understand the principles of project, construction and commercial risk management</b></p> <p>13.5.1 Commercial risk for clients and contractors:</p> <ul style="list-style-type: none"> <li>· client risk – ensuring funding, potential profit analysis</li> <li>· contractor risk at tender stage – the need for an accurate bill of quantities, safety margins, timescales. <b>(CS3)</b></li> </ul> <p>13.5.2 Risk management techniques:</p> <ul style="list-style-type: none"> <li>· identification of risks</li> <li>· reviewing and monitoring risks</li> <li>· mitigation techniques. <b>(CS3)</b></li> </ul>

## Content Area 14: Law

Students will develop an understanding of the legal aspects of design, surveying and planning activities within the construction industry. They will be able to show their awareness of different types of law, including those related to property ownership, the permissions that need to be obtained to complete surveying activities and the types of contract used for construction projects. They will also become aware of the implications of breaches of regulations. They will also demonstrate their knowledge and understanding of intellectual property rights, and the protections that different rights bring.

Content area 14: Law	
CK14.1	<p><b>14.1 Students must understand the different types of law that are present in the English and Welsh legal systems, the differences between them and the sanctions that can be applied under each type of law</b></p> <p>14.1.1 Case law – a set of past rulings by tribunals that meet their respective jurisdictions’ rules to be cited as precedent.</p> <p>14.1.2 Legislation – a law that has been enacted by a legislature or other governing body, or the process of making it.</p> <p>14.1.3 Civil law – a body of rules that defines and protects the private rights of citizens.</p> <p>14.1.4 Criminal law – the body of law that relates to crime.</p>
CK14.2	<p><b>14.2 Students must understand the principles and implications of land law with respect to the built environment</b></p> <p>14.2.1 Different types of land ownership:</p> <ul style="list-style-type: none"> <li>· sole proprietor/owner</li> <li>· government/council owned</li> <li>· concurrent ownership – joint tenancy, joint mortgages, rights of survivorship, the four unities (time, title, interest, possession), shared ownership, tenants in common.</li> </ul> <p>14.2.2 Features of leasehold and freehold ownership and the differences between them.</p> <p>14.2.3 Legislation and regulations impacting on use of land and buildings:</p> <ul style="list-style-type: none"> <li>· implications for construction where there are boundaries and party walls</li> <li>· planning regulations</li> <li>· easements and wayleaves</li> <li>· Building Safety Act</li> </ul>
CK14.3	<p><b>14.3 Students must understand the permissions required to undertake survey work, and the implications of non-compliance</b></p> <p>14.3.1 Persons and organisations from which permission to carry out surveys may be required: the land or building owner, local authority, Ministry of Defence, Civil Aviation Authority (drone use/unmanned aircraft systems).</p>

CK14.4	<p><b>14.4 Students must understand the implications of the law of contract for construction projects, including the scope of types of contract</b></p> <p>14.4.1 Types of contract used in construction:</p> <ul style="list-style-type: none"> <li>· Joint Contracts Tribunal (JCT)</li> <li>· Association of Consultant Architects (ACA) Building Agreement</li> <li>· ICE conditions of contract</li> <li>· International Federation of Consulting Engineers (FIDIC)</li> <li>· New Engineering Contract (NEC).</li> </ul> <p>14.4.2 Implications of law on contracts used in construction:</p> <ul style="list-style-type: none"> <li>· rights and obligations under contracts</li> <li>· conditions of contract</li> <li>· variations in construction contracts.</li> </ul>
CK14.5	<p><b>14.5 Students must understand case law related to the law of tort and the law of landlord and tenant, including duty of care</b></p> <p>14.5.1 Law of tort – liabilities, civil liability for damages, negligence.</p> <p>14.5.2 Law of landlord and tenant – duties of landlords, duties of tenants, leases, eviction, damages, rents.</p>
CK14.6	<p><b>14.6 Students must understand the scope and implications of building regulations, and of breaches of or failure to comply with building regulations for the construction project and key stakeholders</b></p> <p>14.6.1 Scope of the approved documentation:</p> <ul style="list-style-type: none"> <li>· structure – Approved Document A</li> <li>· fire safety – Approved Document B</li> <li>· site preparation and resistance to contaminants and moisture – Approved Document C</li> <li>· toxic substances – Approved Document D</li> <li>· resistance to sound – Approved Document E</li> <li>· ventilation – Approved Document F</li> <li>· sanitation, hot water safety and water efficiency – Approved Document G</li> <li>· drainage and waste disposal – Approved Document H</li> <li>· conservation of fuel and power – Approved Document L</li> <li>· access to and use of buildings – Approved Document M</li> <li>· overheating – Approved Document O</li> <li>· electrical safety in dwellings – Approved Document P</li> <li>· infrastructure for charging electric vehicles – Approved Document S</li> <li>· materials and workmanship – Approved Document 7.</li> </ul> <p>14.6.2 Implications of the failure to comply with building regulations:</p> <ul style="list-style-type: none"> <li>· implications for stakeholders – prosecution (financial penalties, prison sentences), damage to reputation</li> <li>· implications for the project – impact on selling property, enforcement notices.</li> </ul>

CK14.7	<p><b>14.7 Students must understand the importance, implications and ways of protecting intellectual property rights</b></p> <p>14.7.1 Types of intellectual property rights that give automatic protection:</p> <ul style="list-style-type: none"><li>· copyright</li><li>· design rights.</li></ul> <p>14.7.2 Types of intellectual property where protection needs to be applied for:</p> <ul style="list-style-type: none"><li>· trademarks</li><li>· patents</li><li>· registered designs.</li></ul>
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# Scheme of Assessment – Core Component

There are three assessments in the Core component of the *T Level Technical Qualification in Design, Surveying and Planning for Construction*:

- Core Examination Paper 1: Science and Building Technology
- Core Examination Paper 2: Construction Industry and Sustainability
- Employer Set Project.

The mapping, timings, scheduling and preparation for the assessments shown below are for the current specimen assessment material. The actual live assessments will have the same overarching number of tasks and overall focus. However, the order of tasks and the details within the task may change each series.

## Core examination

Paper 1: Science and Building Technology
<b>Written examination: 2.5 hours</b> <b>33% of the core assessments</b> <b>100 marks</b>
<b>Content overview</b> Sampled assessment of application of knowledge and understanding. Content area 1 – Health and safety Content area 2 – Science Content area 3 – Measurement Content area 4 – Building technology Content area 5 – Information and data Content area 6 – Digital technology Content area 7 – Construction mathematical techniques
<b>Assessment overview:</b> <ul style="list-style-type: none"><li>• An externally assessed written examination comprising two sections. Students answer all questions in Section A and Section B. The exam papers will ramp up in difficulty. The test questions will start at the lower end of the grade range and ramp up to questions at the higher end of the grade range.</li><li>• The examination will include short, medium and extended open-response calculations and questions, as well as drawing questions and labelling questions.</li><li>• It will be set and marked by Pearson.</li><li>• It will be timetabled at a time and date specified by Pearson.</li></ul>
<b>Administration</b> This paper must be assessed under examination conditions following <a href="#">JCQs Instructions for Conducting Examinations (ICE)</a> .

## Paper 2: Construction Industry and Sustainability

**Written examination: 2.5 hours**

**33% of the core assessments**

**100 marks**

### **Content overview**

Content area 8 – Design

Content area 9 – Construction and the built environment industry

Content area 10 – Sustainability

Content area 11 – Relationship management

Content area 12 – Commercial business

Content area 13 – Project management

**Content area 14 – Law**

### **Assessment overview**

- An externally assessed written examination comprising two sections. Students answer all questions in Section A and Section B. The exam papers will ramp up in difficulty. The test questions will start at the lower end of the grade range and ramp up to questions at the higher end of the grade range.
- The examination will include short, medium and extended open-response questions, as well as drawing and labelling questions.
- It will be set and marked by Pearson.
- It will be timetabled at a time and date specified by Pearson.

### **Administration**

This paper must be assessed under examination conditions following [JCQs Instructions for Conducting Examinations \(ICE\)](#).

Both examinations will follow the same paper structure but they will assess different Core content, and will be available paper-based. There are two sections in each paper:

- Section A is weighted 40%.
- Section B is weighted 60%.



## Core Examination Assessment Objectives

Assessment Objective			% Weighting		Paper 1	Paper 2
AO1	1a	Demonstrate knowledge and understanding of the content (Knowledge)	12	(i) In isolation	4%	5%
				(ii) Embedded	8%	7%
AO1	1b	Demonstrate knowledge and understanding of the content (Understanding)	22		22%	22%
AO2		Apply knowledge and understanding of the content to different situations and contexts	45		45%	45%
AO3	3a	Analyse and evaluate information and issues related to the content (Analysis)	12		12%	12%
AO3	3b	Analyse and evaluate information and issues related to the content (Evaluation)	9		9%	9%

# Employer Set Project

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## Employer Set Project

**Externally assessed project: 15 hours 30 minutes**

**33% of the core assessments**

**100 marks**

### Content overview

Sampled assessment of application of knowledge and skills.

Content area 1 – Health and safety

Content area 2 – Science

Content area 3 – Measurement

Content area 4 – Building technology

Content area 5 – Information and data

Content area 6 – Digital technology

Content area 7 – Construction mathematical techniques

Content area 8 – Design

Content area 9 – Construction in the built environment industry

Content area 10 – Sustainability

Content area 11 – Relationship management

Content area 12 – Commercial business

Content area 13 – Project management

Content area 14 – Law

### Assessment overview

The project will be set and marked by Pearson and will take place within a four-week window.

The majority of the tasks will be timetabled by the Provider, with the exception of one task which will be timetabled by Pearson to ensure all students undertake it at the same time.

Students will be provided with a client brief and specification, to which they will need to prepare designs and project management documentation. They will need to develop costing documentation and respond to challenges as a group.

The project will be validated by our Employer Validation Panel.

### Pre-release

Students will be provided with a shortened client brief and specification, and given time to research similar projects. This research will inform the students' understanding of the challenges that that project might present, the legal constraints within which the project will need to operate, the probable duration for different stages of the project, and the types of designs that have been used for similar projects.

There are four tasks in the project:

### Task 1: Response to a client brief and initial designs

The students will be given the full brief and specification. They will have to prepare a report that explores the potential challenges for the project, initial design ideas and probable timelines. Students will need to prepare project management documentation that shows these timelines.

## Employer Set Project

### **Task 2: Designs**

Students will need to prepare designs for the proposed building project. They will need to produce sketches of the exterior of the building and the internal layout. They will need to produce a CAD plan or elevation showing a specific detail of the design. Students will produce a presentation with detailed speaker notes that justifies how their design meets the requirements of the brief.

### **Task 3: Costs**

Students will be required to produce costing documentation for an aspect of the project.

### **Task 4: Responding to problems as a team**

Students will be asked to work as a team to respond to problems arising within the scenario. Students will be given time to carry out research and will then need to produce a group presentation/hold a group discussion to present potential solutions to the problem.

### **Administration**

Providers must follow the guidance in the following:

- General Administrative Support Guide
- Administration Support Guide for the specific Technical Qualification Employer Set Project (if applicable)

These are located on the [Training and Admin Support webpage](#).

## Employer Set Project Assessment Objectives

Assessment Objective	Strand	Descriptor
<b>AO1</b>	1. Planning	Plan and research information necessary to present solutions to a brief.
<b>AO2</b>	2. Application	Apply knowledge and skills using a logical approach, working with others to identify issues, solve problems and propose solutions.
<b>AO3</b>	3. Select relevant techniques and resources	Select relevant techniques and resources to respond to a brief.
<b>AO4</b>	4a. English	Use appropriate English in response to a brief to communicate effectively with both technical and non-technical audiences.
	4b. Digital	Use appropriate digital skills in response to a brief to present information and data in a clear and logical way.
	4c. Maths	Use appropriate mathematical skills in response to a brief to identify solutions.
<b>AO5</b>	5a. Project Outcome	Produce proposed construction solutions in response to a brief.
	5b. Review	Review and justify how well the proposed construction solutions meet the brief.

The ESP has targeted weightings to AOs as shown in the table below:

AO1a	AO1b	AO2	AO3a	AO3b	Total
12	22	45	12	9	100
34		45	21		100

## Resources for the delivery of the Core component content

As part of your Provider approval, you will need to show that the necessary material resources and work spaces are available to deliver this Technical Qualification. Where specific resources are required to deliver the content, these are stated in the relevant component. The following resources would be required for this qualification:

### Core:

- CAD software
- traditional drawing equipment
- measuring equipment for forces, time, temperature, sound, lengths and light levels
- rigs for demonstrating mechanical and structural science
- project management software

### Building services design:

- access to current code of practice
- CAD software
- Building services testing equipment

### Surveying and design:

- total stations/surveying equipment
- CAD software
- measurement instruments, tripods and prisms.

### Civil Engineering:

- access to current code of practice
- CAD software
- total stations/surveying equipment

# 4 Occupational Specialisms

## 1. Surveying and Design for Construction and the Built Environment

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### Content Summary

The Occupational Specialist content is separated into three Performance Outcomes, with the skills needed to achieve threshold competence and the knowledge to underpin skill application across the following areas. Where skills are linked to knowledge in the Core Component these are indicated, for example 8.5.3)

### Performance Outcome 1: Measure the built environment

#### What skills do students need to demonstrate?

**SDS1.1** Explore requirements of the task, using open questioning and listening.

#### What underpinning knowledge do students need?

<b>SDK1.1</b>	<p>Students will apply their knowledge of the different types of guidance on permissions required to undertake survey work, including geospatial and digital survey to the survey task. This will include: <b>(E2, E3, E4, D3)</b></p> <ul style="list-style-type: none"><li>● relevant legislation relating to survey work:<ul style="list-style-type: none"><li>○ Civil Aviation Authority (CAA) permission</li><li>○ permissions from landowners or controllers of land</li><li>○ restrictions for filming in public areas</li></ul></li><li>● survey terminology, e.g. back sight, fore sight, datum, reduced level, control points, base line, azimuth, zenith angle, offset, check lines, bearings.</li></ul> <p>Students will explore different types of survey method:</p> <ul style="list-style-type: none"><li>● topographical</li><li>● geological</li><li>● linear</li><li>● structural</li><li>● ecological</li><li>● boundary</li><li>● façade</li><li>● ground</li><li>● measured.</li></ul> <p><b>(Core Ref: 14.3.1)</b></p>
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## What skills do students need to demonstrate?

**SDS1.2** Gather information from appropriate sources specific to the scope of works, including Geographical Information Systems (GIS).

## What underpinning knowledge do students need?

### **SDK1.2**

Students will understand how the internet can provide information on a building's locality in relation to its surrounding geography, and the building's shape and orientation, which supports the measurements in the built environment:

- Ordnance Survey maps
- Printed and online maps
- Geographic Information System (GIS)
- Historic maps and drawings
- Cartographic information
- Other commercially available data.

**(Core Ref: 5.3.5)**

Students will study techniques used to gather and convey data, including geospatial data and other digital engineering techniques that support construction:

**(E1, E2, E3, E4, E5)**

- desk study
- smart buildings
- topographical data, including photographic mapping
- building information management automated monitoring.

**(Core Ref: 6.1.3, 6.1.4)**

Students will learn how to capture, process, manage, use and quality assure data, including geospatial:

**(E1, E2, E3, E4, E5)**

- limitations of use – cost, accuracy, training requirements, accessibility
- measurement standards, guidance and practice, including measurement rules

**(Core Ref: 3.3.1/2/3)**

- point cloud surveying, 3D surveys, laser scanning, data collection, cloud to cloud
- meshed and surfaced models.

**(Core Ref: 6.2.4, 6.3.3)**

## What skills do students need to demonstrate?

**SDS1.3** Determine the level of accuracy required.

## What underpinning knowledge do students need?

<b>SDK1.3</b>	<p>Students will study the application, suitability and use of geospatial equipment in a construction context.</p> <p>This will include:</p> <ul style="list-style-type: none"><li>• the principles and limitations of measurement</li><li>• units of measurement, using appropriate units and contractual arrangements, BS 5606 <b>(Core Ref: 2.4.5, 2.4.7)</b></li><li>• converting between common alternative units – degrees, minutes and seconds from decimal measurements, imperial to metric</li><li>• scientific principles – temperature, atmospheric conditions and how they affect measurements <b>(Core Ref: 2.5.2)</b></li><li>• point density requirements for laser scans</li><li>• standard units, planning surveys to minimise errors</li><li>• point marking and control points.</li></ul> <p>Students will understand the importance of coordinating systems, projects, transformations and datums:</p> <ul style="list-style-type: none"><li>• a coordinate system is a reference system used to represent the locations of geographic features, imagery and observations, such as Global Positioning System (GPS) locations</li><li>• datum terminology:<ul style="list-style-type: none"><li>○ Ordnance Survey Benchmark (OSBM)</li><li>○ Temporary Benchmark (TBM)</li><li>○ reduced level.</li></ul></li><li>• offsetting, triangulation, base lines</li><li>• positioning of profiles, control points, TBMs</li></ul>
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### What skills do students need to demonstrate?

**SDS1.8** Communicate health and safety risks associated with the task and environment, using appropriate methods.

**SDS1.9** Assess health and safety risks associated with the task and environment.

### What underpinning knowledge do students need?

#### **SDK1.4**

Students will apply health, safety and welfare knowledge and understanding to the construction surveying process, and communicate health and safety risks. **(E1, E2, E3, E4, E5)**

Type of accidents and ways to avoid them:

- falls from height:  
**(Core Ref:1.1.3)**
  - make sure access equipment is in good condition
  - prevent people and materials falling from roofs, gable ends, working platforms and open edges, using guard rails, mid rails and toe boards
  - make sure fragile roof surfaces are covered, or secure working platforms with guard rails are used on or below the roof
- working in excavations:
  - shore, cover or barrier excavations to prevent people or vehicles from falling in
  - no lone workers in excavations.
- collapse of structures:
  - support structures (such as walls, beams, chimney breasts and roofs) with props; ensure props are installed by a competent person

The materials used in buildings that are hazardous to health and the periods in history they were in use. **(Core Ref: 1.1.2)**

Have knowledge of the guidance published by the Health & Safety Executive on hazardous materials in buildings. Understand how to recognise the key hazardous materials commonly used in building and be aware of the historical hazards due to the age of the building. Have an awareness of their danger to health, how they can be protected or safely removed.

- Asbestos:
  - Total ban in 2003 with materials being phased out from the 1970s  
**(Core Ref: 1.1.2)**
  - Types of asbestos, 'blue asbestos' (crocidolite), 'brown asbestos' (amosite) and 'white asbestos' (chrysotile) and the dangers of each type
  - Where asbestos was used and the products it was incorporated in, insulation, ceiling tiles, cement products, gaskets in pipework, protection in electrical boards, pipe and tank lagging, fire stopping and flooring.
- Electrical:  
**(Core Ref: 1.1.2)**
  - Fluorescent lamps and tubes
  - Electrical equipment, insulating chemicals, early 20th century

- Lead:
    - Lead paint was in general use until the 1980s
    - Lead pipes were unlikely to be in use after 1970, more likely in Victorian buildings
  - Lime plaster with horse hair:
    - Was in general use until beginning of the twentieth century, but may be some instances up until the middle of the twentieth century.
  - Exposure to hazardous materials:
    - asbestos
    - biological hazards
    - animal waste
  - Ground contamination:
    - Factory sites, tanning factories, foundries
    - Chemical plants
    - Gas storage, coal gas, natural gas
    - Hospital buildings, radioactive waste, oil
- Safe working practices:
- electricity:
    - use correct voltage tools, 110V safety isolating transformer or batteries
    - do not use excavators or power tools near suspected buried services
  - protect members of the public, the client and others:
    - (Core Ref: 1.5.1)**
    - secure the site – netting, signage.
  - Completion of risk assessment and method statements.
    - (Core Ref: 1.1.7)**

## What skills do students need to demonstrate?

**SDS1.10** Select and use tools and equipment with accuracy and efficiency.

## What underpinning knowledge do students need?

<b>SDK1.5</b>	<p>Students will understand good survey practice.</p> <ul style="list-style-type: none"><li>● Whole and part, local versus national and understand the types of error to support error propagation:<ul style="list-style-type: none"><li>○ how errors impact on the accuracy of fieldwork surveys</li><li>○ plastic tapes – stretching</li><li>○ levels – calibration errors</li><li>○ theodolites:<ul style="list-style-type: none"><li>– bubble and electronic plummets off-centre errors</li><li>– horizontal collimation errors</li><li>– vertical collimation errors</li></ul></li><li>○ electronic distance measurement: <b>(D1)</b><ul style="list-style-type: none"><li>– scale and index errors</li></ul></li><li>○ performance of systematic checks on surveying instruments:<ul style="list-style-type: none"><li>– tapes (calibration against standardised steel tapes)</li><li>– levels (two-peg test)</li></ul></li><li>○ theodolites<ul style="list-style-type: none"><li>– vertical axis check</li><li>– transit axis check</li><li>– spire check.</li></ul></li></ul></li><li>● The principles and limitations of measurement.</li><li>● Calculations required.</li><li>● Adjustment of errors, closing the survey/traverse.</li><li>● Geospatial equipment; its applications, suitability and use. <b>(D1)</b> <b>(Core Ref: 6.2.4)</b></li><li>● Traditional equipment: total stations, theodolites, levels (automatic, spirit, water), tapes.</li><li>● Laser levels, mobile mapping, 3D laser scanning, Global Navigation Satellite System (GNSS) (GPS, GLONASS, Galileo etc.) <b>(D1)</b> <b>(Core Ref: 6.3.3)</b></li><li>● Drone surveys, antennae and accessories. <b>(D1)</b> <b>(Core Ref: 6.3.2)</b></li></ul>
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### What skills do students need to demonstrate?

**SDS1.4** Capture data, using appropriate measurement methods.

**SDS1.11** Operate equipment and perform tasks safely.

### What underpinning knowledge do students need?

<b>SDK1.6</b>	<p>Students will understand types of measurement and detection method.</p> <p>Students will understand linear measurements, offsets, heights, points, angular measurements (circle bearings, inclination), contouring, gridding.</p> <p>Students will understand methods of collecting and recording data, including manual methods, data collectors, mobile apps. <b>(D1) (D2) (D3) (D4)</b></p> <ul style="list-style-type: none"><li>• Good survey practice, e.g. whole to the part, local versus national, error propagation, reducing angular errors.</li><li>• The importance of coordinating systems, projects, transformations and datums.</li><li>• Offsetting, triangulation, base lines.</li><li>• Positioning of profiles, control points, temporary benchmarks (TBMs).</li></ul>
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### What skills do students need to demonstrate?

**SDS1.5** Process data, using appropriate techniques.

### What underpinning knowledge do students need?

<b>SDK1.7</b>	<ul style="list-style-type: none"><li>• Downloading data into CAD and modelling programs.</li><li>• Using and incorporating data into drawings.</li><li>• Calculations required and how to undertake them, using spreadsheets, tables, big data.</li><li>• Rise and fall, height of collimation.</li><li>• Traverse adjustment.</li><li>• Digital engineering techniques and appropriate software. <b>(D5, D4)</b></li><li>• Area and volume calculations, trigonometry, Pythagoras, addition and subtraction of angles.</li></ul>
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### What skills do students need to demonstrate?

**SDS1.6** Extract and manage data, using appropriate techniques.

### What underpinning knowledge do students need?

- |               |   |
|---------------|---|
| <b>SDK1.8</b> | <ul style="list-style-type: none"><li>● Primary GIS data capture techniques: <b>(D1, D3, D4)</b><ul style="list-style-type: none"><li>○ using remote sensing and surveying technologies to capture the data, using either raster data capture or vector data capture.</li></ul></li><li>● Secondary GIS data capture techniques: <b>(D1, D3, D4)</b><ul style="list-style-type: none"><li>○ using technologies such as scanning, manual digitising, vectorisation and photogrammetry to capture data.</li></ul></li><li>● Traditional methods of collecting and recording data:<ul style="list-style-type: none"><li>○ data collectors, mobile apps</li></ul></li></ul> |
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### What skills do students need to demonstrate?

**SDS1.7** Quality assure the surveying measurements.

### What underpinning knowledge do students need?

- |               |   |
|---------------|---|
| <b>SDK1.9</b> | <ul style="list-style-type: none"><li>● Checking calibration certificates, closing measurements, checking digital measurements with approximate manual methods, two-peg test.</li><li>● Calibration and human error; correcting for curvature, sag, slope. <b>(M10)</b></li><li>● Survey logs, Internet of Things, e.g. machine to machine. <b>(M6)</b></li><li>● Identifying anomalous results.</li><li>● Adjustment of errors, closing the survey/traverse.</li><li>● Smart buildings, building information management, automated monitoring.</li></ul> |
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### What skills do students need to demonstrate?

**SDS1.12** Manage waste, including the quantification, classification and disposal of waste.

### What underpinning knowledge do students need?

<b>SDK1.10</b>	<p>Students will apply methods used to quantify site waste produced from excavations, demolition and general site waste:</p> <ul style="list-style-type: none"><li>● mathematical techniques: <b>(Core Ref: 7.1.1)</b><ul style="list-style-type: none"><li>○ regular areas and volumes</li><li>○ irregular areas and volumes</li><li>○ trapezoidal rule</li><li>○ mid-ordinate rule</li><li>○ Simpson's rule</li></ul></li><li>● calculation of waste material from site levelling and cut activities by using grid levels and site contours</li><li>● how bulking factors are applied to materials</li><li>● the classification of site waste as hazardous and non-hazardous; disposal methods. <b>(E2)</b></li></ul>
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## Performance Outcome 2: Analyse the built environment

### What skills do students need to demonstrate?

**SDS2.1** Sequence and prioritise tasks.

### What underpinning knowledge do students need?

<b>SDK2.1</b>	<p>Students will plan and programme construction activities for small and medium-sized developments using the following: <b>(D1, D2, D4)</b></p> <ul style="list-style-type: none"><li>● long- and short-term programmes</li><li>● types of reporting: <b>(Core Ref:13.3.2)</b><ul style="list-style-type: none"><li>○ critical path</li><li>○ activity lists</li><li>○ Gantt charts</li><li>○ site storage <b>(Core Ref: 10.6.1)</b></li><li>○ just-in-time</li><li>○ activity lists</li><li>○ schedules</li><li>○ progress reports</li><li>○ health and safety reports</li><li>○ waste management plans and reports</li><li>○ materials ordering and usage</li></ul></li><li>● workforce management techniques</li><li>● noise and planning constraints, Control of Pollution Act 1974, Sec. 60–61</li><li>● cost and time implications, including cash flow, payment schedules and payment terms</li><li>● constraints: hours of work, site location, area and neighbouring properties, funding, planning</li></ul>
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## What skills do students need to demonstrate?

**SDS2.2** Analyse information available to determine requirements of the task.

## What underpinning knowledge do students need?

<b>SDK2.2</b>	<p>Students will develop an understanding of the information that is required to plan and organise construction activities: <b>(E1, (E2, E4, E5, E2, D1, D2, D4)</b></p> <ul style="list-style-type: none"><li>● scoping for a project – inception, assessing client objectives, feasibility studies, cost-benefit analysis</li><li>● adhering to current legislation – global warming, ethical approach to the built environment <b>(Core Ref: 9.4.1)</b></li><li>● information and documentation:<ul style="list-style-type: none"><li>○ site plans</li><li>○ planning constraints</li><li>○ resource documents</li><li>○ contractor requirements</li><li>○ considerate constructors.</li></ul></li></ul> <p>Students will understand how and why sustainability seeks to balance environmental and social objectives and the need for an ethical approach to the built environment: <b>(Core Ref: 10.2.3)</b></p> <ul style="list-style-type: none"><li>● embedded energy/carbon, short- and long-term, payback, flexible design, re-appropriation of land and buildings</li><li>● cost-benefit analysis</li><li>● whole life, including decommissioning <b>(Core Ref: 8.4.1)</b></li><li>● adhering to current legislation <b>(Core Ref: 10.3.1)</b></li><li>● impact of global warming.</li></ul>
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### What skills do students need to demonstrate?

**SDS2.3** Interpret information and data, including from visual and other sources.

### What underpinning knowledge do students need?

<b>SDK2.3</b>	<p>Students will understand how information is applied to a project in order to develop accurate plans and programmes of work. <b>(E1, E2, E3, E4, E5, D1, D2, D4)</b></p> <ul style="list-style-type: none"><li>● Project programs, relevance and techniques for reporting:<ul style="list-style-type: none"><li>○ contractual arrangements</li><li>○ embedded energy/carbon, short- and long-term, payback, flexible design, re-appropriation of land and buildings.</li></ul></li><li>● How sustainability is embedded into solutions:<ul style="list-style-type: none"><li>○ supply chain – sustainable certification, local supplies, waste management</li><li>○ off-site construction methods</li><li>○ low-energy solutions, reduced embodied energy</li><li>○ water use and removal, including on-site solutions</li><li>○ land usage, brownfield sites.</li></ul></li><li>● Legal obligations relating to pollution and waste:<ul style="list-style-type: none"><li>○ Environmental Protection Act 1990</li><li>○ Water – The Environmental Permitting (England and Wales) Regulations 2016</li><li>○ local enforcement and fines.</li></ul></li></ul>
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### What skills do students need to demonstrate?

**SDS2.4** Convey data.

### What underpinning knowledge do students need?

<b>SDK2.4</b>	<p>Students will develop an understanding and application of digital workflows in a construction design environment to convey data such as measurement and cost data, using appropriate techniques. <b>(E3, E2, E4, E5, D1, D2, D4)</b></p> <p>The relevance and use of digital engineering techniques:</p> <ul style="list-style-type: none"><li>● Protocols <b>(Core Ref: 9.9.2)</b></li><li>● BIM</li><li>● BEPs</li><li>● Employer's Information Requirements (EIR) <b>(Core Ref: 9.9.4)</b></li><li>● Common Data Environments (CDE). <b>(Core Ref: 9.9.3)</b></li></ul>
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## Performance Outcome 3: Design the built environment

### What skills do students need to demonstrate?

**SDS3.1** Identify information and data required to complete the task.

### What underpinning knowledge do students need?

<b>SDK3.1</b>	<p>Students will understand how designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programs. <b>(D1, D2)</b></p> <ul style="list-style-type: none"><li>● Key considerations: <b>(Core Ref: 13.4.3)</b><ul style="list-style-type: none"><li>○ design briefs</li><li>○ work stages</li><li>○ schedules</li><li>○ specifications</li><li>○ statutory obligations</li><li>○ recommendations</li><li>○ programmes.</li></ul></li><li>● The design team: <b>(Core Ref: 11.1.2)</b><ul style="list-style-type: none"><li>○ roles and responsibilities, legal obligations</li><li>○ drawing techniques <b>(Core Ref: 8.5.1)</b></li><li>○ inclusive design, including equality and diversity, impact assessment. <b>(Core Ref: 8.3.4)</b></li></ul></li><li>● Client brief:<ul style="list-style-type: none"><li>○ outline and detailed proposals</li><li>○ pre-contract information <b>(Core Ref: 13.4.3)</b></li><li>○ communication between the different parties</li><li>○ design freeze.</li></ul></li><li>● Concept: <b>(Core Ref: 8.1)</b><ul style="list-style-type: none"><li>○ detailed design</li><li>○ production information.</li></ul></li><li>● Measurement in design: amounts, volumes, distances.</li><li>● Principles of heritage and conservation.</li><li>● Listed buildings, Historic England, National Heritage List. <b>(Core Ref: 8.3.3)</b></li><li>● Conservation areas: designation, management, restrictions. <b>(Core Ref: 10.5.1)</b></li></ul>
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### What skills do students need to demonstrate?

**SDS3.2** Quality assure information and data, including third-party expertise.

**SDS3.4** Use suitable data, quality assured in line with best practice.

**SDS3.7** Manage data in a collaborative environment.

### What underpinning knowledge do students need?

<b>SDK3.2</b>	<p>Students will understand about the use, application and land management of design data and information. <b>(D1, D2, D4)</b></p> <ul style="list-style-type: none"><li>● Key design details: <b>(Core Ref: 13.3.1)</b><ul style="list-style-type: none"><li>○ sketch drawings</li><li>○ models</li><li>○ site plans</li><li>○ plans and sections</li><li>○ detail drawings</li><li>○ schedules</li><li>○ non-standard items</li><li>○ adjoining structures</li><li>○ designs for temporary structures</li><li>○ method statements</li><li>○ specifications.</li></ul></li><li>● The importance of communicating design intent to the client to meet contractual requirements to the construction development team. <b>(Core Ref: 11.9.3)</b></li><li>● Communication between the different parties. <b>(Core Ref: 11.9.1)</b></li><li>● Use of different consultants in pre-construction, construction and post-construction.</li></ul>
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### What skills do students need to demonstrate?

**SDS3.9** Manage relationships.

### What underpinning knowledge do students need?

<b>SDK3.3</b>	<p>Students will develop an understanding of the importance of relationship management in the work environment and throughout the project development process: <b>(E2, E3, E4)</b> <b>(Core Ref: 11.1.2)</b></p> <ul style="list-style-type: none"><li>● team development</li><li>● design team – roles, responsibilities, legal obligations</li><li>● consultation requirements – third-party expertise, input and knowledge</li><li>● negotiation, mediation and conflict management techniques</li><li>● communication planning and meetings</li><li>● processes of collaborative design, e.g. coordination of team input and clash management.</li></ul>
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### What skills do students need to demonstrate?

**SDS3.3** Conduct precedent research, including best practice, benchmarks and design guides.

### What underpinning knowledge do students need?

<b>SDK3.4</b>	<p>Students will use information and research to develop construction designs:</p> <ul style="list-style-type: none"><li>● site plans, plans and sections, detail drawings, schedules, non-standard items, adjoining structures, designs for temporary structures, method statements and specifications <b>(Core Ref: 13.4.3)</b></li><li>● concept production</li><li>● influencing factors – local vernacular, reference to recent developments, client's vision, architectural styles <b>(Core Ref: 8.1.2)</b></li><li>● the use and importance of specifications, as applicable to design guides and legislation</li><li>● environmental performance measures that must be met, and how they are measured <b>(Core Ref: 10.4.4)</b></li><li>● Constructing Excellence, Environmental Management Systems (EMS).</li></ul>
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## What skills do students need to demonstrate?

**SDS3.10** Provide creative solutions to challenges arising from requirements.

## What underpinning knowledge do students need?

### **SDK3.5**

Students will develop the skills required to adapt and make changes to designs following changes to requirements.

- Client's brief, outline and detailed proposals, pre-contract information, BREEAM.

**(Core Ref: 10.4.2)**

- The implications of statutory obligations to designs:
  - utility diversion
  - water management
  - accessibility for waste removal
  - planning guidance
  - building regulations
  - best practice guides
  - highways.

Students will produce sketch drawings, architectural drawings and digital models, and apply the following design methods:

**(Core Ref: 8.5.1, 8.5.2)**

- understanding the relevance of measurement in the design process – area (net and gross) volume, height and length  
**(Core Ref: 7.1.1, 9.5.2)**
- ergonomics and anthropometrics, approved documents, standard sizes for materials and components  
**(Core Ref: 14.6.1)**
- inclusive design, including equality and diversity, by impact assessment  
**(Core Ref: 8.3.4)**
- access for all, flexibility, fitness for purpose, being accommodating, being realistic.

### What skills do students need to demonstrate?

**SDS3.5** Model design, using digital software and other tools and techniques.

**SDS3.6** Present appropriate design information and data, using different methods and formats.

### What underpinning knowledge do students need?

**SDK3.6** Students will understand techniques used to produce accurate construction drawings and models:

**(Core Ref: 8.5.1, 8.5.2)**

- the level of detail needed in designs for different situations, and the importance of detail in communicating the design intent
  - technical drawing techniques – manual and digital methods
  - use of appropriate scales for drawings
  - production of virtual models, different views and walkthroughs
  - detailed design and production information
  - standard specifications – content, methods of construction, construction details
  - digital design tools and photorealism
  - production of manual design section, plan and detail sketches/drawings
  - use of computer-aided design (CAD) to produce section, plan and detail drawings
  - types of 2D and 3D CAD
- (Core Ref: 6.2.3)**
- line type, wireframe, surface modelling, solid modelling
  - Autodesk, SolidWorks, Bentley MicroStation, Archima, SketchUp, TurboCAD
- (Core Ref: 6.2.3)**
- digital specification tools – the NBS (national building specification), BS 1192
  - digital data – spreadsheets and schedules digital presentation, PowerPoint, image handling and desktop publishing, brochures and reports.

## What skills do students need to demonstrate?

**SDS3.8** Communicate design and construction risks, using appropriate methods.

## What underpinning knowledge do students need?

<b>SDK3.7</b>	<p>Students will understand the duties of the designer in relation to design risks, produce designers risk assessments and the CDM regulations: <b>(Core Ref: 1.1.4)</b></p> <ul style="list-style-type: none"><li>● CDM Regulations 2015, the duties of the designer, the identification of design of hazards and risks, and methods of assessment, e.g. Design Risk Assessments (CDM 2015)</li><li>● safety schemes in procurement (SSIP)</li><li>● further development of risk assessments, including for changing design, site or weather conditions</li><li>● risks through the whole life cycle of the development – design, procurement, construction, operation, decommissioning</li><li>● implementation of the principles of prevention – eliminate/avoid, control/reduce, adapt to new techniques/technologies, replace dangerous with less dangerous, give collective measures priority over individual measures</li><li>● use of red, amber, green lists for items to eliminate, control or encourage within designs</li><li>● fire and emergency safety – the Hackitt Review, escape routes, compartmentation, alarms, emergency service access</li><li>● the key outcomes of the Hackitt Review and how they apply to designers</li><li>● designer safety skills, knowledge and experience</li><li>● use of Building Information Modelling (BIM) to identify potential hazards during construction and in-use; facilities management.</li></ul> <p><b>(Core Ref: 6.1.7)</b></p>
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### What skills do students need to demonstrate?

**SDS3.11** Adapt design proposals in response to design constraints and stakeholder feedback, in terms of time, cost and material factors.

### What underpinning knowledge do students need?

<b>SDK3.8</b>	<p>Students will understand how designs sometimes need to be altered and changed following changes in circumstances. These could include:</p> <ul style="list-style-type: none"><li>• changes to budget</li><li>• site conditions</li><li>• legislative changes</li><li>• incorrect pre-contract information</li><li>• issues with material supplies and labour.</li></ul> <p>Students will understand methods used to implement design changes:</p> <ul style="list-style-type: none"><li>• architects' instructions – change of orders, confirmation of verbal instructions</li><li>• production of new contracts and design information</li><li>• planning alterations.</li></ul>
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## Performance Outcome 4: Verify delivery of the built environment

### What skills do students need to demonstrate?

**SDS4.1** Verify suitability of information and data from appropriate sources specific to the scope of works.

### What underpinning knowledge do students need?

<b>SDK4.1</b>	<p>Students will understand verification of appropriate project information:</p> <ul style="list-style-type: none"><li>• plans and drawings <b>(Core Ref: 13.4.3)</b></li><li>• contracts and tender documentation</li><li>• variations</li><li>• progress reports</li><li>• site instructions</li><li>• drawing changes and versions</li><li>• consultant reports.</li></ul> <p>Students will understand information from appropriate enforcement authorities that could influence the final project: <b>(E1, E2, E3, E4)</b> <b>(Core Ref: 4.6.1)</b></p> <ul style="list-style-type: none"><li>• planning and building control notices</li><li>• Health and Safety Executive notices:<ul style="list-style-type: none"><li>○ improvement notices</li><li>○ prohibition notices.</li></ul></li></ul> <p>Students will understand types of measurement for combined data:</p> <ul style="list-style-type: none"><li>• checking interfaces</li><li>• valuations.</li></ul> <p>Students will understand about sustainability:</p> <ul style="list-style-type: none"><li>• environmental performance measures that must be met, and how they are measured <b>(Core Ref: 10.4.4)</b></li><li>• principles of heritage and conservation. <b>(Core Ref: 10.5.1/2)</b></li></ul>
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## What skills do students need to demonstrate?

**SDS4.2** Interpret information and data, including from visual and other sources.

## What underpinning knowledge do students need?

<b>SDK4.2</b>	<p>Students will interpret different types of project information. As well as the information above, these could include:</p> <p><b>(Core Ref: 13.3.1)</b></p> <ul style="list-style-type: none"><li>● cash flow projections</li><li>● variations</li><li>● key performance indicators (KPIs)</li></ul> <p><b>(Core Ref: 13.3.2)</b></p> <ul style="list-style-type: none"><li>● project schedules</li><li>● design statements</li><li>● contents of the project file</li><li>● legal obligations relating to pollution and waste management:<ul style="list-style-type: none"><li>○ Environmental Protection Act 1990</li><li>○ Water: Environmental Permitting Regulations 2010</li></ul></li><li>● environmental sustainability assessment methods, BREEAM, BRE Home Quality Mark, Latham Report and Egan Report</li></ul> <p><b>(Core Ref: 10.4.2)</b></p> <ul style="list-style-type: none"><li>● Considerate Constructors Scheme (CCS)</li><li>● requirements of Ultra Site status</li><li>● consultant reports</li><li>● financial control (QS) report:<ul style="list-style-type: none"><li>○ budget</li><li>○ cost plan</li><li>○ contingency funds.</li></ul></li></ul>
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### What skills do students need to demonstrate?

**SDS4.3** Present information, using oral, visual and written communication.

### What underpinning knowledge do students need?

<b>SDK4.3</b>	<p>Students will develop an understanding of the different methods to communicate and present project information. These methods can include: <b>(E1, E2, E3, E4, E5, D1, D2, D4)</b></p> <ul style="list-style-type: none"><li>• progress reporting processes <b>(Core Ref: 11.9.2)</b></li><li>• variation documents <b>(Core Ref: 11.9.2)</b></li><li>• extensions of time <b>(Core Ref: 11.9.3)</b></li><li>• presentations</li><li>• meetings</li><li>• emails and letters</li><li>• noticeboards</li><li>• weekly/monthly/quarterly cost reporting.</li></ul>
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### What skills do students need to demonstrate?

**SDS4.4** Use software with accuracy to verify specific items, utilising appropriate tools.

### What underpinning knowledge do students need?

<b>SDK4.4</b>	<p>Students will use digital methods as applied to the verification of the built environment. These will include: <b>(D1, D3, D4, D5)</b></p> <ul style="list-style-type: none"><li>• project management software</li><li>• spreadsheets</li><li>• quantity take-off software</li><li>• databases <b>(Core Ref: 8.5.2)</b></li><li>• CAD</li><li>• BIM.</li></ul>
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### What skills do students need to demonstrate?

**SDS4.5** Complete costings analysis through the use of market rates and spreadsheet software, including best value and whole life costing.

### What underpinning knowledge do students need?

<b>SDK4.5</b>	<p>Students will learn techniques used in the costing and valuation of construction projects: <b>(E1, E2, E3, E4, D1, D2,)</b></p> <ul style="list-style-type: none"><li>• techniques for value engineering, e.g. cost, quality and time, and critical analysis of the process <b>(Core Ref: 10.6.1)</b></li><li>• industry valuation standards, guidance and practice, and how they are used to verify delivery of the built environment</li><li>• advance payments, retention guarantees, milestone payments, contingencies, claims and damages</li><li>• whole life cycle costing</li><li>• selection of plant, materials and equipment</li><li>• assessing alternatives</li><li>• cost allocation.</li></ul>
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### What skills do students need to demonstrate?

**SDS4.6** Apply appropriate mathematical techniques in a construction context.

### What underpinning knowledge do students need?

<b>SDK4.6</b>	<p>Students will complete calculations of areas, volumes, quantities, units and tolerances, as required for the measurement process to be conducted: <b>(Core Ref: 9.4.1)</b></p> <ul style="list-style-type: none"><li>• production of final quantities and bills of quantities <b>(Core Ref: 9.5.2)</b></li><li>• valuation benchmarking and how it is used to verify delivery of the built environment</li><li>• tender prices, preliminary costs, preambles, measured work, prime costs and provisional sums <b>(Core Ref: 9.6.1)</b></li><li>• identification and analysis of elements and their functions</li><li>• building up rates and costs <b>(Core Ref: 9.6.1/2)</b></li><li>• rules of measurement and contractual implications, including RICS rules <b>(Core Ref: 3.3.4)</b></li><li>• final summaries.</li></ul>
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# Scheme of Assessment – Surveying and Design for Construction and the Built Environment

There is a single synoptic assessment for the Occupational Specialism, which is an extended 'design, development and implementation' project. The synoptic element of the project is important to ensure students are able to demonstrate threshold competence: this is the principal reason why the occupational specialism is assessed via a single extended project assessment to ensure that students are able to evidence all the skills required by the Performance Outcomes.

The mapping, timings and scheduling and preparation for assessment shown below are for the current specimen assessment material, the assessment will have the same overarching number of tasks and overall focus but the order of tasks and the detail within the task may change each series.

<b>Occupational Specialism assessment: Surveying and Design for Construction and the Built Environment</b>
<b>Externally assessed project: 30 hours</b> <b>180 marks</b>
<b>Content overview</b> Students are required to: <ul style="list-style-type: none"><li>• measure the built environment</li><li>• analyse the built environment</li><li>• design the built environment</li><li>• verify delivery of the built environment.</li></ul>
<b>Assessment overview</b> This project will be externally set and marked by Pearson. Students will respond to a client brief to measure a site, analyse information, design construction solutions and verify delivery of those construction solutions. The project will consist of a portfolio of evidence, including an observation report to evidence practical skills, where they occur, to meet threshold competence where appropriate. This will be accompanied by video evidence. The project will show students demonstrating the following tasks: <b>Task 1: Planning a survey</b> Students will produce a detailed plan and risk assessment to survey a site within given constraints. They will produce an email that summarises this plan. <b>Task 2: Practical surveying</b> Students will undertake a practical surveying task. Measurements will be recorded using surveying equipment. Data will be used to create a graphical representation of the survey. <b>Task 3: Completed pre construction survey, calculations and report to the groundworks contractor</b> Students will perform calculations in relation to the survey that will take place on the site. They will produce a report that covers an aspect of waste management. <b>Task 4: Quantity surveying</b> Students will produce a spreadsheet and valuations for the project.

## Occupational Specialism assessment: Surveying and Design for Construction and the Built Environment

### Task 5: Redesign of given buildings

Students will redesign based on given information, using annotated sketches.

### Task 6: Project management and stakeholder management

Students will produce project management documentation and a stakeholder engagement plan.

### Task 7: Design

Students will produce a 3D model and a supporting report and presentation.

### Administration

Providers must follow the guidance in the following:

- General Administrative Support Guide
- Administration Support Guide for the specific Technical Qualification Employer Set Project (if applicable)

These are located on the [Training and Admin Support webpage](#).

Performance Outcomes		Weighting	
		Raw marks	% of total marks
PO1	Measure the built environment	45	25%
PO2	Analyse the built environment	41.4	23%
PO3	Design the built environment	45	25%
PO4	Verify delivery of the built environment	48.6	27%

## Preparation for assessment

Students will submit evidence for tasks in either hard copy or electronic/digital format. Where an electronic/digital submission is made, students need access to computers and the appropriate software. A summary of the submission requirements for each task is given below.

Task	Evidence type
1	Electronic submission: report, risk assessment and correspondence.
2	Electronic submission: observation record, survey data, video, CAD drawing.
3	Hard copy submission: calculations and report.
4	Electronic submission: valuation report and spreadsheet
5	Hard copy submission: sketches, justification and designers' risk assessment.
6	Electronic submission: project management report.
7	Electronic submission: 3D model, report justifying design, presentation.

A summary of preparation work that providers need to carry out before assessments take place is given below.

Task	Preparation work required
Task 2	Providers will need to source a site of a suitable size to carry out a practical task.

## 2. Civil Engineering

### Content Summary

The content is separated into three Performance Outcomes, with the skills needed to achieve threshold competence and the knowledge to underpin skill application across the following areas. Where skills are linked to knowledge in the Core Component these are indicated, for example 8.5.3).

### Performance Outcome 1: Analyse civil engineering solutions

What skills do students need to demonstrate?
<b>CES1.2</b> Identify information and data requirements.
<b>CES1.5</b> Select data collection and analysis methods.
<b>CES1.7</b> Gather relevant information and data, i.e. relevant to the task.

What underpinning knowledge do students need?	
<b>CEK1.1</b>	<p>Review of task set to identify the key information and data required to complete the task. <b>(E1, E2, E3, E4, E5)</b></p> <p>Key considerations for design preparations:</p> <ul style="list-style-type: none"> <li>● requirements and constraints, and their impact on the initial project brief and design process, for combinations of rural, urban, greenfield and brownfield settings</li> <li>● types of civil engineering work undertaken – civil engineering construction methods and techniques to be considered for the following: <ul style="list-style-type: none"> <li>○ foundations and substructure – different types of foundation (strip, pad, raft, piles in plain or reinforced concrete, basements), relevant techniques, processes, materials and associated construction plant <b>(Core Ref: 4.2.1, 4.2.2)</b></li> <li>○ superstructures – frames, connections, floors, wall claddings, roof coverings, relevant techniques, processes, materials and associated construction plant, structural steel frames, precast concrete frames, in-situ frames, timber frames. <b>(Core Ref: 4.2.3)</b></li> <li>○ portal frames – structural steel, timber, concrete. <b>(Core Ref: 4.2.3)</b></li> <li>○ external works – flexible, composite and rigid pavement construction, retaining walls (concrete, brick, drainage), SUDS (sustainable urban drainage systems), culverts, manholes, separate systems, combined systems, relevant techniques, processes and associated construction plant <b>(Core Ref: 4.2.5)</b></li> <li>○ bridges – beam, arch, truss, suspension, cable-stayed, cantilever <b>(Core Ref: 4.2.6)</b></li> </ul> </li> </ul>



	<ul style="list-style-type: none"> <li>○ railway track engineering – methods for earthwork construction in a rail context</li> <li>● client requirements for the project outcomes – building use, to include domestic, industrial, commercial, retail, health, cultural and recreation <b>(Core Ref: 9.1.1)</b></li> <li>● surveying of construction projects, to provide relevant information and data requirements to support the design solution.</li> </ul> <p>Risk assessments for projects or part of a project on review of scenario:</p> <ul style="list-style-type: none"> <li>● identification of hazards <b>(Core Ref: 1.1.4)</b></li> <li>● control measures</li> <li>● pre-survey: <ul style="list-style-type: none"> <li>○ data and information from pre-survey</li> <li>○ geological survey – bore holes, trial pits; groundwater – water table, contamination, ground load bearing, foundations. <b>(Core Ref: 2.8.3, 8.3.2)</b></li> </ul> </li> </ul> <p>Select data collection, analysis methods and techniques appropriately for civil engineering tasks.</p> <p>Statistical methods:</p> <ul style="list-style-type: none"> <li>● select and apply statistical techniques correctly to solve practical construction problems <b>(Core Ref: 7.3.1)</b></li> <li>● statistical sampling methods to ensure samples are collected without bias and that results will be reliable</li> <li>● sampling methods, e.g. systematic, stratified, simple random</li> <li>● statistical techniques – processing large groups of data to achieve mean, median, mode and standard deviation, cumulative frequency, quartiles, quartile range, methods of visual presentation. <b>(Core Ref: 7.3.1, 7.3.2)</b></li> </ul> <p>How to capture, process and manage data for a construction task:</p> <ul style="list-style-type: none"> <li>● types of survey</li> <li>● identification of the correct tools and equipment to be used</li> <li>● permissions required to undertake survey work.</li> <li>● compliance with legislation, i.e. health and safety.</li> </ul> <p>Statistical methods:</p> <ul style="list-style-type: none"> <li>● Use statistical techniques: <ul style="list-style-type: none"> <li>○ processing large groups of data to achieve mean, median, mode and standard deviation, cumulative frequency, quartiles, quartile range <b>(Core Ref: 7.3.1)</b></li> <li>○ methods of visual presentation.</li> </ul> </li> <li>● Select and apply statistical techniques correctly to solve practical construction problems. <b>(Core Ref: 7.3.1, 7.3.2)</b></li> <li>● Use statistical sampling methods to ensure samples are collected without bias and that results will be reliable.</li> </ul>
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	<p>Research activities:</p> <ul style="list-style-type: none"> <li>● precedent research</li> <li>● benchmarks <b>(Core Ref: 12.6.2)</b></li> <li>● case studies</li> <li>● previous surveys</li> <li>● historical data and information.</li> </ul>
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### What skills do students need to demonstrate?

**CES1.6** Inspect the suitability of tools and equipment.

### What underpinning knowledge do students need?

<b>CEK1.2</b>	<p>The set-up and use of different tools and equipment to undertake a site investigation for a project:</p> <ul style="list-style-type: none"> <li>● correct PPE</li> <li>● appropriate surveying equipment in accordance with landowner requirements, including drones (private landowner, Network Rail, Port Authority, Highways Agency, etc.) <b>(Core Ref: 14.3.1)</b></li> <li>● appropriate surveying equipment to record measurements: <b>(Core Ref: 6.3.3)</b> <ul style="list-style-type: none"> <li>○ lasers</li> <li>○ Global Positioning System (GPS) (Core Ref: 6.2.4)</li> <li>○ digital levels</li> <li>○ machine guidance</li> <li>○ automated total stations</li> <li>○ Global Navigation Satellite System (GNSS)</li> </ul> </li> <li>● testing of surveying equipment</li> <li>● uses and advantages of emerging technology in setting out.</li> </ul>
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### What skills do students need to demonstrate?

**CES1.8** Use tools and equipment with accuracy.

**CES1.9** Operate safely and apply good housekeeping.

### What underpinning knowledge do students need?

#### **CEK1.3**

Use and operate surveying tools and equipment safely, with accuracy and understanding:

- use of appropriate PPE – comply with health and safety in differing construction environments, surveying of contaminated land  
**(Core Ref: 1.1.3, 1.1.7)**
- how errors in measurement may occur and how they could be reduced
- identification of types of measurement error:
  - systematic
  - cumulative errors
- the set-up and use of different equipment
- types of measurement:  
**(Core Ref: 3.2.1, 3.2.2)**
  - linear – running, offset
  - levelling – height measurement
  - angular – horizontal, vertical height
  - cross checking  
**(Core Ref: 7.1.1)**
  - area (net and gross)
  - volumes
  - height
  - length
- how measurement relates to the design process:
  - using the correct measurement for its intended purpose  
**(Core Ref: 3.2.1)**
  - setting out, techniques for setting-out points and developing the physical position of elements of a building from the plan.
- measurement standards, guidance and practice
- identification of types of measurement error: systematic, cumulative errors
- advantages of using different types of surveying equipment in reducing measurement errors  
**(Core Ref: 3.1.1)**
- Civil Engineering Standard Method of Measurement (CESMM) – measurement **(Core Ref: 3.3.2)** of quantities
- specification of tolerances.

## What skills do students need to demonstrate?

**CES1.1** Sequence and prioritise individual tasks.

## What underpinning knowledge do students need?

<b>CEK1.4</b>	<p>Understand and apply project management techniques that could be used in civil engineering projects considering project and construction risk management, including the personnel involved in the project and project management solutions to problems. <b>(E1, E2, E3, E4, D1, D2, D3, D5)</b></p> <p>Project and construction risk management: <b>(Core Ref: 8.3.8, 9.9.1)</b></p> <ul style="list-style-type: none"><li>● stages of a construction process:<ul style="list-style-type: none"><li>○ feasibility studies</li><li>○ design</li><li>○ construction</li><li>○ maintenance</li><li>○ repair</li><li>○ alteration</li><li>○ refurbishment</li><li>○ contractor procurement</li><li>○ commissioning</li><li>○ handover</li></ul></li><li>● members of the building/construction team involved in project management and their interaction: <b>(Core Ref: 9.7.1)</b><ul style="list-style-type: none"><li>○ management at head office or site level<ul style="list-style-type: none"><li>– technical and professional roles</li><li>– architect</li><li>– planner</li><li>– buyer</li><li>– estimator</li><li>– quantity surveyor</li><li>– civil engineer</li><li>– structural engineer</li><li>– resident engineer</li></ul></li><li>○ supervisory roles<ul style="list-style-type: none"><li>– contract supervisor</li><li>– general foreperson</li><li>– site supervisor</li></ul></li><li>○ general operative roles <b>(Core Ref: 9.7.2)</b><ul style="list-style-type: none"><li>– labourer</li><li>– drain layer</li><li>– steel fixer</li><li>– plant operative</li><li>– driver</li></ul></li></ul></li></ul>
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- craft roles  
**(Core Ref: 9.7.2)**
  - joiner
  - bricklayer
  - plasterer
  - electrician
  - plumber
- planning techniques:
  - resource planning – human, plant and machinery, materials, domestic, nominated subcontractors  
**(Core Ref: 13.3.1)**
  - production of long- and short-term programmes
  - scheduling of material requirements  
**(Core Ref: 13.4.3)**
  - requisitioning
  - ordering
  - receiving and checking
  - site layout plan showing planned storage, site circulation, sight lines, tower cranes, concentric load limits, access and egress routes
  - labour management techniques (work and method study; control and organisation of labour)
  - plant management (hire, lease or purchase; utilisation and control)
  - relevant documentation
  - software for producing a construction programme
  - software for monitoring a construction programme
- documentation:
  - head office and site documentation (schedules, requisitions, method statements, budgets, cost plans)  
**(Core Ref: 13.3.2)**
  - bar charts
  - Gantt diagrams
  - schedules
  - critical path analysis
- advantages and disadvantages of resource management techniques, including Building Information Modelling (BIM).  
**(Core Ref: 9.9.2)**
- comparison of software systems that can facilitate planning and organisation, and control processes
- techniques for value engineering:  
**(Core Ref: 13.2.1)**
  - cost
  - quality
  - time
- use of Building Information Modelling (BIM) in the collaborative production of construction information; advantages and disadvantages.  
**(Core Ref: 9.9.3)**

## What skills do students need to demonstrate?

**CES1.3** Assess health and safety risks associated with the task.

## What underpinning knowledge do students need?

### **CEK1.5**

Conduct risk assessments associated with civil engineering work to reduce health and safety risks. Consider stages of construction to develop suitable risk assessments:

- specific risk managements developed for different stages of civil engineering projects, including:  
**(Core Ref: 1.1.7)**
  - identification of hazards
  - likelihood of harm
  - control measures
- people at risk
- risk assessments to be completed, including excavation of deep trenches, construction of retaining walls, etc.  
**(Core Ref: 1.1.7)**
- statutory constraints and their requirements, including subsequent updates:  
**(Core Ref: 1.1.1)**
  - Health and Safety at Work Act 1974
  - Construction (Design and Management) Regulations 2015.  
**(Core Ref: 1.1.4)**

Understand the materials used in buildings that are hazardous to health and the periods in history they were in use. Have knowledge of the guidance published by the Health & Safety Executive on hazardous materials in buildings. Understand how to recognise the key hazardous materials commonly used in building and be aware of the historical hazards due to the age of the building. Have an awareness of their danger to health, how they can be protected or safely removed.

**(Core Ref: 1.3.1, 1.6.2)**

- Asbestos:
  - Total ban in 2003 with materials being phased out from the 1970s
  - Types of asbestos, 'blue asbestos' (crocidolite), 'brown asbestos' (amosite) and 'white asbestos' (chrysotile) and the dangers of each type
  - Where asbestos was used and the products it was incorporated in, insulation, ceiling tiles, cement products, gaskets in pipework, protection in electrical boards, pipe and tank lagging, fire stopping and flooring
- Electrical:
  - Fluorescent lamps and tubes
  - Electrical equipment, insulating chemicals, early 20th century
- Lead:
  - Lead paint was in general use until the 1980s
  - Lead pipes were unlikely to be in use after 1970, more likely in Victorian buildings

	<ul style="list-style-type: none"> <li>● Lime plaster with horse hair: <ul style="list-style-type: none"> <li>○ Was in general use until beginning of the twentieth century, but may be some instances up until the middle of the twentieth century.</li> </ul> </li> <li>● Exposure to hazardous materials: <ul style="list-style-type: none"> <li>○ asbestos</li> <li>○ biological hazards</li> <li>○ animal waste</li> </ul> </li> <li>● Ground contamination: <ul style="list-style-type: none"> <li>○ Factory sites, tanning factories, foundries</li> <li>○ Chemical plants</li> <li>○ Gas storage, coal gas, natural gas</li> <li>○ Hospital buildings, radioactive waste, oil</li> </ul> </li> </ul>
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### What skills do students need to demonstrate?

**CES1.4** Adapt actions to the level of risk.

### What underpinning knowledge do students need?

<b>CEK1.6</b>	<p>Review processes to adapt construction methods to reduce the level of risk: <b>(E1, E2, E3, E4)</b></p> <ul style="list-style-type: none"> <li>● consider further development of risk assessments, including changing design, site or weather conditions <b>(Core Ref: 1.5.1)</b></li> <li>● consider statutory constraints and their requirements, including subsequent updates: <ul style="list-style-type: none"> <li>○ Health and Safety at Work Act 1974 <b>(Core Ref: 1.1.1)</b></li> <li>○ Construction (Design and Management) Regulations 2015. <b>(Core Ref: 1.1.4)</b></li> </ul> </li> </ul>
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## What skills do students need to demonstrate?

**CES1.12** Analyse environments against client brief to identify potential issues and problems.

## What underpinning knowledge do students need?

<b>CEK1.7</b>	<p>Review the task set to identify the changing environment, to develop and present solutions to civil engineering construction projects. This should include consideration of sustainable construction methods, structural testing methods, inclusive design and use of materials:</p> <ul style="list-style-type: none"><li>● the need to embed sustainability into solutions:<ul style="list-style-type: none"><li>○ consideration of sustainability in feasibility of projects as a key consideration in the design of projects <b>(Core Ref: 8.3.8, 8.4.1)</b></li><li>○ balancing economic, environmental and social objectives <b>(Core Ref: 12.2.1/2)</b></li></ul></li><li>● the different techniques:<ul style="list-style-type: none"><li>○ energy-based techniques: <b>(Core Ref: 10.2.1)</b><ul style="list-style-type: none"><li>– reduced energy consumption</li><li>– improved energy efficiency</li><li>– use of renewable and alternative sources of energy</li></ul></li><li>○ materials-based techniques: <b>(Core Ref: 10.1.2)</b><ul style="list-style-type: none"><li>– specification of renewable materials</li><li>– specification of durable and long-lasting materials requiring minimum maintenance</li><li>– consideration of embodied energy <b>(Core Ref: 10.2.1)</b></li><li>– low-energy manufacture of materials and components</li></ul></li><li>○ waste-based techniques: <b>(Core Ref: 10.1.1)</b><ul style="list-style-type: none"><li>– producing less waste and recycling more</li><li>– off-site prefabrication</li><li>– modern methods of construction</li><li>– brownfield reuse of sites</li></ul></li></ul></li><li>● inclusive design, including equality and diversity through impact statements; designing to meet Equality Act 2010: <b>(Core Ref: 11.6.1)</b><ul style="list-style-type: none"><li>○ accessibility to buildings</li><li>○ consideration for people with disabilities</li><li>○ car parking design for people with disabilities</li></ul></li><li>● material properties: <b>(K5.1, 5.2, 5.3)</b><ul style="list-style-type: none"><li>○ types of material, including mass and density: <b>(Core Ref: 2.1.2)</b><ul style="list-style-type: none"><li>– concrete</li><li>– glass</li><li>– timber</li></ul></li></ul></li></ul>
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- steel
- impact of the environment on building materials for various scenarios, degradation methods and types, preventive and reduction measures, and impact of failure of a single material in a composite element  
**(Core Ref: 2.1.1)**
- sources of degradation, including corrosion, chemical degradation and their cause; natural agents  
**(Core Ref: 2.1.1)**
- embedded energy
- recycling potential
- earthworks and excavation:
  - groundwater control by pumping
  - embankments
  - cuttings
  - retaining walls
  - relevant techniques
  - processes
  - earth moving equipment
  - remedial measures to prevent and reduce degradation, and their benefits and drawbacks; use of special paints and protective coatings; use of sulphate resisting cement (SRC); importance of water/cement ratio
- material failure:  
**(Core Ref: 2.1.1)**
  - concrete and reinforced concrete
  - brickwork
  - timber – external and internal applications
  - steel
  - mortars
- effects of temperature changes on construction materials  
**(Core Ref: 2.5.6)**
- types of heat: latent, sensible
- the effect of temperature change on the properties of materials:
  - changes of state, evaporation, expansion and contraction.  
**(Core Ref: 2.5.3)**

## What skills do students need to demonstrate?

**CES1.15** Produce sketches based on information and data.

## What underpinning knowledge do students need?

<b>CEK1.8</b>	<p>Produce sketch diagrams to support civil engineering design solutions, and to demonstrate understanding of civil engineering construction techniques and methods: <b>(E1)</b></p> <ul style="list-style-type: none"><li>● outline solution – to communicate use of space and appropriate form of construction:<ul style="list-style-type: none"><li>○ 2D and 3D sketches of initial ideas, including internal and external views, plans and elevations: <b>(Core Ref: 8.5.1)</b><ul style="list-style-type: none"><li>– freehand sketched</li><li>– single-point perspective</li><li>– two-point perspective</li><li>– isometric views</li></ul></li></ul></li><li>● design production:<ul style="list-style-type: none"><li>○ production of designs for commercial and industrial building design, including foundation details, and the design of beams and columns <b>(Core Ref: 4.2.1/2)</b></li><li>○ external works, including retaining walls, drainage, highway construction details, portal frame design and basic bridge design components <b>(Core Ref: 4.2.3/4/5/6)</b></li></ul></li><li>● communicating information effectively through sketches:<ul style="list-style-type: none"><li>○ clear communication, using technical annotations to ensure correct information is shared and clear understanding of the design is communicated <b>(Core Ref: 8.5.1)</b></li><li>○ clear communication of key features, including external fabric, roof type, service access, circulation space, windows, doors, linking elements, columns to foundations, beams to columns, retaining wall types, highway pavement specifications, drainage details. <b>(Core Ref: 4.2.3/4/5/6, 8.5.1)</b></li></ul></li></ul>
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## What skills do students need to demonstrate?

**CES1.10** Extract relevant information from appropriate sources.

## What underpinning knowledge do students need?

<b>CEK1.9</b>	<p>Review the task set to identify the key source information and data required to complete sub-tasks. Understand the level of detail needed in designs: <b>(E1, E4, E5)</b></p> <ul style="list-style-type: none"><li>• project information: <b>(Core Ref: 9.4.1)</b><ul style="list-style-type: none"><li>○ information used in the production of building designs:<ul style="list-style-type: none"><li>– client requirements <b>(Core Ref: 13.3.1)</b></li><li>– site constraints</li><li>– planning constraints</li><li>– statutory constraints</li><li>– environmental constraints</li><li>– social constraints</li><li>– economic constraints</li><li>– sustainability</li></ul></li><li>○ initial project brief – its purpose and content: <b>(Core Ref: 8.3.1, 9.9.1, 13.4.3)</b><ul style="list-style-type: none"><li>– spatial requirements</li><li>– desired project outcomes</li><li>– site information</li><li>– budget requirements</li></ul></li><li>○ initial project brief to generate and develop design ideas and specifications.</li></ul></li></ul>
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### What skills do students need to demonstrate?

**CES1.11** Quality assure the processes used to collect information and data against protocols and standards.

### What underpinning knowledge do students need?

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| <b>CEK1.10</b> | <p>Understand the testing of materials processes and procedures to quality assure the collection of subsequent test data results: <b>(D1, D3)</b></p> <ul style="list-style-type: none"><li>● methods used to test construction materials:<ul style="list-style-type: none"><li>○ concrete test methods – slump, concrete cube</li><li>○ timber – stress grading</li><li>○ steel – tensile testing</li><li>○ soil sampling – trial holes, boring</li><li>○ sieve analysis and grading tests</li><li>○ chemical composition tests</li><li>○ plate compaction tests</li></ul></li><li>● statistical sampling methods to ensure samples are collected without bias and that results will be reliable.<br/><b>(Core Ref: 7.3.1, 7.3.2)</b></li><li>● sampling methods, including systematic, stratified, simple random.</li></ul> |
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## What skills do students need to demonstrate?

**CES1.13** Carry out calculations related to the scope of work.

## What underpinning knowledge do students need?

<b>CEK1.11</b>	<p>Complete mathematical calculations to support design and development and understand how these are used in civil engineering projects:</p> <ul style="list-style-type: none"><li>● application of mathematical techniques and formulae to support civil engineering projects:<ul style="list-style-type: none"><li>○ practical construction problems involving perimeters, areas and volumes, including for simple and compound shapes: <b>(Core Ref: 7.1.1)</b><ul style="list-style-type: none"><li>– rectangles</li><li>– trapeziums</li><li>– triangles</li><li>– prisms</li><li>– circles</li><li>– spheres</li><li>– pyramids</li><li>– cones</li><li>– regular and irregular surface areas and volumes</li></ul></li><li>○ use of mensuration formulae and basic calculus in civil engineering (mid-ordinate rule, trapezoidal rule, Simpson's rule)</li><li>○ practical construction problems, including surveying, setting out, dimensions of pitched roof and similar: <b>(Core Ref: 7.1.2/3/4)</b><ul style="list-style-type: none"><li>– geometric techniques to determine length, area and volume for shapes containing straight lines and curves</li><li>– use of trigonometry to determine dimensions in 2D and 3D <b>(Core Ref: 7.1.2/3)</b></li></ul></li><li>○ trigonometric techniques:<ul style="list-style-type: none"><li>– sine rule <b>(Core Ref: 7.1.3)</b></li><li>– cosine rule</li><li>– triangle area rules</li></ul></li></ul></li><li>● understanding the need for accuracy in calculations:<ul style="list-style-type: none"><li>○ techniques and methods – mathematical operations, rounding, decimal places, significant figures, approximation, truncation errors and accuracy</li></ul></li><li>● analysis of structural elements, including beams, walls, struts, ties, frames and columns; effect of different loading conditions and failure under load to enable design of structural elements <b>(Core Ref: 2.3.4)</b></li><li>● relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams <b>(Core Ref: 2.3.1, 2.3.5)</b></li></ul>
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	<ul style="list-style-type: none"> <li>determining the centroid of regular and irregular rectangular structural/engineering sections, including calculations of first moment of area, second moment of area, the parallel axis theorem and section modulus</li> <li>coplanar forces; Hooke's law; loading, shear forces and bending moments of beams. <b>(Core Ref: 2.3.2)</b></li> </ul> <p>Solve structural mechanics problems: <b>(Core Ref: 2.3.5, 2.3.1)</b></p> <ul style="list-style-type: none"> <li>problems relating to beams, columns, frames</li> <li>beams – different loading conditions, point loads, uniformly distributed loads (UDLs), combined loads, reactions, shear force values, bending moment values, relationship between shear force and bending moment, point of contraflexure, simply supported beams with cantilever ends, simply supported beams without cantilever ends <b>(Core Ref: 2.3.3)</b></li> <li>columns – different loading conditions, point loads, axially loaded, eccentrically loaded, effective length, maximum stress</li> <li>frameworks – different loading conditions, point loads, statically determinate, pin-jointed, subject to dead loads and wind loads.</li> </ul>
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### What skills do students need to demonstrate?

**CES1.14** Use appropriate techniques to check accuracy of analysis.

**CES1.16** Model analysed information and data, including geotechnical, structural and materials, as appropriate for audience, using digital software.

**CES1.17** Collate information and data into digital engineering software.

### What underpinning knowledge do students need?

<b>CEK1.12</b>	<p>Use and application of procedures to check the accuracy of the civil engineering solutions obtained: <b>(D1) (D3)</b></p> <ul style="list-style-type: none"> <li>computer software to analyse and verify manual solutions are correct <b>(Core Ref: 6.1.7)</b></li> <li>predictive models</li> <li>application of the principles of moments and the laws of static equilibrium.</li> </ul> <p>Application of mathematical techniques of approximation and estimations to check accuracy.</p> <p>Application and use of digital software to support and confirm design solutions developed:</p> <ul style="list-style-type: none"> <li>design of retaining walls to relevant factors of safety</li> <li>shear force and bending moments diagrams</li> <li>cut-and-fill solutions</li> <li>use of digital presentation, image handling and desktop publishing.</li> </ul>
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## Performance Outcome 2: Design civil engineering solutions

### What skills do students need to demonstrate?

**CES2.1** Extract relevant information and data.

### What underpinning knowledge do students need?

<b>CEK2.1</b>	<p>Design preparation requirements: (E1, E2, E3, E4, D4)</p> <ul style="list-style-type: none"><li>● preparation of design briefs <b>(Core Ref: 9.9.1)</b></li><li>● consideration of work stages</li><li>● schedules (Core Ref: 13.3.1)</li><li>● specifications</li><li>● recommendations</li><li>● programmes.</li><li>● Extract key information and data required to complete civil engineering problems:<ul style="list-style-type: none"><li>○ types of data and information:<ul style="list-style-type: none"><li>– geotechnical – bore holes, trial pits; groundwater – water table, contamination, ground load bearing <b>(Core Ref: 2.8.3, 5.3.5)</b></li><li>– structural</li><li>– visual</li><li>– materials for secondary sources</li></ul></li><li>○ client requirements for the project outcomes.</li></ul></li><li>● Extract key data to design structural components:<ul style="list-style-type: none"><li>○ consideration of solutions for structural elements, loading issues and potential failure in design</li><li>○ structural elements, including effect of different loading conditions and modes of failure: <b>(Core Ref: 2.3.4, 2.1.1)</b><ul style="list-style-type: none"><li>– beam</li><li>– column</li><li>– retaining wall</li><li>– framework design problems</li><li>– studs, ties, struts.</li></ul></li></ul></li><li>● Extract relevant information to consider the appropriateness of materials to be used in civil engineering projects:<ul style="list-style-type: none"><li>○ use of special paints, protective coatings; use of sulphate resisting cement (SRC); importance of water/cement ratio <b>(Core Ref: 2.1.1)</b></li><li>○ materials: structural steel, masonry, timber, reinforced concrete, glass, bricks.</li></ul></li></ul>
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### What skills do students need to demonstrate?

**CES2.3** Conduct precedent research into potential solutions to a problem, including best practice, benchmarks and design guides.

### What underpinning knowledge do students need?

<b>CEK2.2</b>	<p>Undertake precedent research to solve civil engineering project problems: <b>(M1, M2, E1, E2, E3)</b></p> <ul style="list-style-type: none"><li>• best practice <b>(Core Ref: 12.6.2)</b></li><li>• benchmarks</li><li>• design guides</li><li>• case study research of forms of construction, including methods of excavation, types of foundation, structural forms, retaining walls, drainage, highway design, earthworks, etc.</li><li>• valuation benchmarking and how this is used to verify delivery of the built environment</li><li>• technical audits to confirm design and outputs comparison with similar projects.</li></ul>
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### What skills do students need to demonstrate?

**CES2.5** Assess commercial risk related to potential solutions.

### What underpinning knowledge do students need?

<b>CEK2.3</b>	<p>Analyse civil engineering projects to assess the commercial risk. <b>(M5) (D4)</b> Consideration of feasibility of projects and a key consideration in the design of projects. <b>(Core Ref: 8.3.1)</b></p> <ul style="list-style-type: none"><li>• Design and specification of construction projects:<ul style="list-style-type: none"><li>○ reduction in energy usage</li><li>○ minimisation of pollution</li><li>○ reduction in embedded energy</li><li>○ specification of environmentally friendly/renewable materials</li><li>○ reuse of existing buildings and sites.</li></ul></li><li>• Project management considerations:<ul style="list-style-type: none"><li>○ simple environmental impact assessments (EIAs) <b>(K4.1)</b></li><li>○ improved management of construction sites</li></ul></li></ul>
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- clear policies and objectives:
  - reduction in wastage  
**(Core Ref: 10.6.1)**
  - increase in recycling  
**(Core Ref: 10.7.2)**
  - noise management
  - dust and dirt control
  - light pollution
- sharing of good practice
- raising awareness; communication of information.
- Fit-for-purpose construction design to meet the needs of the present without compromising the ability of future generations to meet their own needs:
  - social progress that recognises the needs of everyone
  - effective protection of the environment
  - prudent use of natural resources
  - maintenance of high and stable levels of economic growth and employment.
- Economic role of infrastructure in economic growth; relationship of public and private sectors; role of civil engineering professionals in assessing demand; construction and financing.  
**(Core Ref: 10.2.1, 12.4.1, 8.4.1)**
- Life cycle issues: development, adaptation, maintenance and repair, demolition and sustainability of infrastructure.
- Analysis of existing site conditions to plan for future project proposals.
- Verification of initial analysis during construction, to include:
  - site investigation:  
**(Core Ref: 2.8.3, 5.3.1)**
    - site history
    - site surveys
    - site geology
    - ground investigation – potential ground contaminants, water table, contamination
    - ground load bearing capacity – soil type, settlement, subsistence
    - earthworks – general excavation, earth moving equipment, concreting equipment
    - groundwater control by pumping
    - embankments
    - cuttings
    - retaining walls
    - relevant techniques and processes
    - materials and associated construction plant.
- Balancing benefits and opportunities with constraints (cost-benefit analysis, environmental benefits, health and safety risks, product life cycle considerations).  
**(Core Ref: 8.3.7)**

## What skills do students need to demonstrate?

**CES2.12** Use appropriate techniques to check accuracy of measurements, including scale and proportion, e.g. Ground Validation Points (GVP), known measurements.

## What underpinning knowledge do students need?

### **CEK2.4**

Complete fieldwork activities to capture, process and manage data with accuracy.

- Techniques for setting-out points and developing the physical positions of elements of a building from the plan:
  - establishing level datums on a construction site and to carry out control surveys to determine coordinates of stations
  - control surveys – procedures, calculations
  - procedures – to determine coordinates and stations, traversing, free station including use of relative coordinates, whole circle bearings and distances
  - setting out and checking corner pegs for a small building, using appropriate equipment and techniques; setting out pegs and profiles to control construction of a small house, constraints on positioning; application of arithmetic and simple trigonometry
  - process to set out a framed building
  - the uses and advantages of emerging technology in setting out
  - the use of traditional surveying equipment
  - the use of modern surveying technology: lasers, Global Positioning Systems (GPS), digital levels, machine guidance, automated total stations.
- Ground Validation Points (GVP):
  - known measurements
  - scale and proportion.
- Types of measurement and relevance:
  - linear – running, offset
  - levelling – height measurement
  - angular – horizontal, vertical height
  - cross checking
  - area (net and gross)  
**(Core Ref: 7.1.1)**
  - volume
  - height
  - length.
- How measurement relates to the design process:
  - use of methods to predict estimated costs of future projects
  - use of correct measurement for its intended purpose.

	<ul style="list-style-type: none"> <li>● Measurement standards, guidance and practice: <b>(Core Ref: 3.1.1, 3.1.2)</b> <ul style="list-style-type: none"> <li>○ identification of types of measurement error – systematic, cumulative errors</li> <li>○ evaluation of the advantages of using different types of surveying equipment in reducing measurement errors</li> <li>○ Civil Engineering Standard Method of Measurement (CESMM) – measurement of quantities <b>(Core Ref: 3.3.2)</b> <ul style="list-style-type: none"> <li>○ specification of tolerances</li> <li>○ valuations.</li> </ul> </li> </ul> </li> </ul>
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### What skills do students need to demonstrate?

**CES2.2** Quality assure provided data.

### What underpinning knowledge do students need?

<b>CEK2.5</b>	<p>Understand material testing procedures in order to meet design requirements. Ensure sampled materials are collected without bias or affecting the reliability of test results.</p> <ul style="list-style-type: none"> <li>● Methods used to test materials: <ul style="list-style-type: none"> <li>○ concrete test methods – slump, concrete cube</li> <li>○ timber – stress grading</li> <li>○ steel – tensile testing</li> <li>○ soil sampling – trial holes, boring</li> <li>○ sieve analysis and grading tests</li> <li>○ chemical composition tests</li> <li>○ plate compaction tests.</li> </ul> </li> <li>● Statistical sampling methods to ensure samples are collected without bias and that results will be reliable. <b>(Core Ref: 7.3.1/2)</b></li> <li>● Sampling methods, including systematic, stratified, simple random.</li> </ul>
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## What skills do students need to demonstrate?

**CES2.8** Select methods to present information.

## What underpinning knowledge do students need?

### **SDK2.6**

Select and use software and drawing techniques to support civil engineering design solutions and to demonstrate understanding of civil engineering construction techniques and methods. **(E1)**

- Digital design tools:
  - production of manual design section, plan and detail sketches/drawings **(Core Ref: 8.5.1, 8.5.2)**
  - use of computer-aided design (CAD) to produce section, plan and detail drawings
  - types of CAD:
    - Autodesk AutoCAD
    - Autodesk AutoCAD LT
    - Autodesk Revit
    - Autodesk 3D Max
    - Autodesk Inventor
    - SolidWorks
    - Bentley MicroStation
    - Archima
    - SketchUp
    - CAD freeware.
- Production of a range of accurate scale construction drawings: **(Core Ref: 8.5.1, 8.5.2)**
  - floor plans, detailed sections through civil engineering components
  - component drawings, site plans, block plans, isometric drawings
  - digital specification tools, e.g. the NBS, BS 1192
  - digital data – spreadsheets and schedules
  - digital presentations, PowerPoint, image handling and desktop publishing – brochures and reports.

The level of detail needed in designs: **(E4)**

- design production:
  - production of designs for commercial and industrial building design, including foundation details and the design of beams and columns **(Core Ref: 4.2.1/2/3)**
  - external works, including retaining walls and embankments/cuttings **(Core Ref: 4.2.5/6)**
  - infrastructure: drainage, including separate and combined systems, SUDs design, culverts, types of manhole (concrete or brick) **(Core Ref: 4.2.5/6)**
  - highway construction forms (flexible, rigid, composite forms of construction), including footpath details and drainage requirements **(Core Ref: 4.2.3)**
  - portal frame design

	<ul style="list-style-type: none"> <li>○ basic bridge design components, including abutments, foundation design <b>(Core Ref: 4.2.6)</b></li> <li>○ consideration of port infrastructure, including access roads, portal frame construction of sheds, concrete pier decking</li> <li>○ outline solution – to communicate use of space and appropriate form of construction, 2D and 3D sketches of initial ideas, including internal and external views, plans and elevations – freehand sketched, single-point perspective, two-point perspective, isometric views <b>(Core Ref: 8.5.1/2)</b></li> <li>● importance and ways of communicating effectively.</li> <li>● clear communication using technical annotations to ensure correct information is shared and clear understanding of the design is communicated. <b>(Core Ref: 11.9.1/2/3)</b></li> <li>● techniques used to produce accurate construction drawings: <b>(E4)</b></li> <li>● conventions used in survey drawings – appropriate scales for survey drawings</li> <li>● production of survey drawings to incorporate: <ul style="list-style-type: none"> <li>○ level survey plan</li> <li>○ plotting linear survey lines accurately to scale</li> <li>○ spot levels</li> <li>○ grid levels</li> <li>○ contours</li> <li>○ site cross section</li> <li>○ long section detail</li> <li>○ cut-and-fill cross section</li> </ul> </li> <li>● Application of corrected traverse station coordinates to plot a closed traverse.</li> </ul>
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## What skills do students need to demonstrate?

**CES2.4** Think creatively, adapting to challenges arising from requirements.

## What underpinning knowledge do students need?

### **CEK2.7**

Consider the scenario and changing environment to develop civil engineering solutions to civil engineering construction projects: **(E1, E2, E3, E4)**

- types of civil engineering work undertaken – civil engineering construction methods and techniques to be considered for the following:
  - foundations and substructure – different types of foundation (strip, pad, raft, piles in plain or reinforced concrete, basements), relevant techniques, processes, materials and associated construction plant **(Core Ref: 4.2.1, 4.2.2)**
  - superstructures – frames, connections, floors, wall claddings, roof coverings, relevant techniques, processes, materials and associated construction plant, structural steel frames, precast concrete frame, in situ frames, timber frames **(Core Ref: 4.2.3)**
  - portal frames – structural **steel, timber, concrete** **(Core Ref: 4.2.3)**
  - external works – flexible, composite and rigid pavement construction, retaining walls (concrete, brick, drainage), SUDS (sustainable urban drainage systems), culverts, manholes, separate systems, combined systems, relevant techniques, processes and associated construction plant **(Core Ref: 4.2.5)**
  - bridges – beam, arch, truss, suspension, cable-stayed, cantilever **(Core Ref: 4.2.6)**
  - railway track engineering – methods for earthwork construction in a rail context
  - role and responsibilities of civil engineers from inception to completion of small civil engineering projects – design, development, construction, maintenance
  - infrastructure (road, rail, harbour, airports, major services; component parts of infrastructure). **(Core Ref: 4.2.6)**
- Design appropriate structural components to take into account ground conditions present.

## What skills do students need to demonstrate?

**CES2.7** Resolve technical issues in the design.

## What underpinning knowledge do students need?

<b>CEK2.8</b>	<p>Identify and resolve technical issues in the design of civil engineering design projects.</p> <p>Technical issues in design preparations:</p> <ul style="list-style-type: none"><li>● meeting requirements and constraints</li><li>● change of client requirements in relation to project outcomes, structure use and form, external works</li><li>● potential remodelling</li><li>● future extension potential to meet residential needs and business expansion <b>(Core Ref: 8.3.1)</b></li><li>● external and internal aesthetics <b>(Core Ref: 8.2.1)</b></li><li>● technical issues</li><li>● issues with the types and use of materials</li><li>● need for sustainability <b>(Core Ref: 8.2.4)</b></li><li>● need for energy efficiency</li><li>● using alternative types of energy source</li><li>● schedule issues</li><li>● specification issues</li><li>● statutory considerations</li><li>● implications of statutory obligations to design:<ul style="list-style-type: none"><li>○ statutory constraints and their requirements, including subsequent updates:<ul style="list-style-type: none"><li>– Construction (Design and Management) Regulations 2015 <b>(Core Ref: 1.1.4)</b></li><li>– CDM Regulations, the duties of the designer, the identification of hazards/risks at design and methods of assessment, e.g. Design Risk Assessments (CDM 2015)</li><li>– safety schemes in procurement (SSIP)</li><li>– further development of risk assessments, including for changing design, site or weather conditions <b>(Core Ref: 1.1.7)</b></li><li>– risks through the whole life cycle of the development</li><li>– design, procurement, construction, operation, decommissioning</li></ul></li><li>○ environmental constraints:<ul style="list-style-type: none"><li>– avoidance of air, water and noise pollution</li><li>– the findings of Environmental Impact Assessments (EIAs) and their use in developing designs for a project</li></ul></li></ul></li></ul>
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	<ul style="list-style-type: none"><li>○ importance of specifications to design guides:<ul style="list-style-type: none"><li>– ensuring designs are safe <b>(Core Ref: 8.2.5)</b></li><li>– following best practice</li><li>– producing economical designs</li><li>– producing sustainable designs</li></ul></li><li>○ how specifications relate to legislation: <b>(Core Ref: 1.1.1)</b><ul style="list-style-type: none"><li>– compliance with Health and Safety at Work Act (HASAWA) 1974</li><li>– compliance with Construction (Design and Management) Regulations 2015 <b>(Core Ref: 1.1.4)</b></li><li>– compliance with British standards and approved codes of practice.</li></ul></li><li>● utility diversion:<ul style="list-style-type: none"><li>○ compliance with drainage and other services; building and design requirements.</li></ul></li></ul>
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## What skills do students need to demonstrate?

**CES2.9** Determine performance of materials.

## What underpinning knowledge do students need?

<b>CEK2.9</b>	<p>Select an appropriate material to meet an economical and sustainable design for a civil engineering project. Verify the specification of materials used in the construction of a project and the application of structural mechanics calculations and tests. <b>(E1, E2, E3)</b></p> <p>Understand the properties of materials: <b>(Core Ref: 2.1.1)</b></p> <ul style="list-style-type: none"><li>● strength:<ul style="list-style-type: none"><li>○ tensile</li><li>○ compressive</li><li>○ shear</li><li>○ hardness</li><li>○ toughness</li></ul></li><li>● mass and density</li><li>● bending stiffness</li><li>● fatigue and creep</li><li>● embedded energy</li><li>● recyclability.</li></ul> <p>Understand the degradation of construction materials:</p> <ul style="list-style-type: none"><li>● the impact of the environment on building materials for various scenarios, degradation methods and types, prevention and reduction measures, and impact of failure of a single material in a composite element <b>(Core Ref: 4.1.3, 2.1.1)</b></li><li>● sources of degradation and their causes:<ul style="list-style-type: none"><li>○ natural agents – ageing, ultraviolet (UV) radiation timber infestation – insect attack, fungal <b>(Core Ref: 2.1.1)</b></li><li>○ timber decay – wet rot, dry rot, lichens and mosses</li><li>○ moisture movement – capillary action, shrinkage</li><li>○ exposure conditions – weathering, freeze-thaw, thermal ageing, creep, humidity, loadings</li><li>○ chemical degradation – acid rain, sulphate, alkalis, leaching</li><li>○ corrosion in metals – oxidation.</li></ul></li><li>● use of special paints and protective coatings; use of sulphate resisting cement (SRC); importance of water/cement ratio <b>(Core Ref: 2.1.1)</b></li></ul>
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	<ul style="list-style-type: none"> <li>• material failure: <b>(Core Ref: 2.1.1)</b> <ul style="list-style-type: none"> <li>○ concrete and reinforced concrete</li> <li>○ brickwork</li> <li>○ timber – external and internal applications</li> <li>○ steel</li> <li>○ mortars</li> </ul> </li> <li>• effects of temperature changes on construction materials</li> <li>• types of heat: latent, sensible <b>(Core Ref: 2.5.1)</b> <ul style="list-style-type: none"> <li>○ effect of temperature change on the properties of materials: changes of state, evaporation, expansion and contraction</li> </ul> </li> <li>• behaviour of structural elements under load: beams, columns, frameworks.</li> </ul>
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### What skills do students need to demonstrate?

**CES2.11** Model information, using appropriate digital software and other tools.

### What underpinning knowledge do students need?

<b>CEK2.10</b>	<p>Use digital software to model civil engineering design solutions: <b>(D1, D2, D3)</b></p> <ul style="list-style-type: none"> <li>• assessment of the use of BIM in the production of accurate structural design information and the collaborative environment of structural design <b>(Core Ref: 6.1.7)</b></li> <li>• use of CAD (Revit or equivalent) software to present solutions in 2D and 3D format</li> <li>• sketching/drawing.</li> </ul>
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### What skills do students need to demonstrate?

**CES2.13** Draw on a range of media to communicate a design proposal.

### What underpinning knowledge do students need?

<b>CEK2.11</b>	<ul style="list-style-type: none"> <li>• Select and use a range of media to communicate civil engineering design proposals: use of digital presentations, image handling and desktop publishing, e.g. brochures and reports. <b>(E2, E2, E3, D3)</b></li> </ul>
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## What skills do students need to demonstrate?

**CES2.6** Apply mathematical principles to the scope of work.

## What underpinning knowledge do students need?

<b>CEK2.12</b>	<p>Complete mathematical calculations to support the design and development of civil engineering projects:</p> <ul style="list-style-type: none"><li>● application of mathematical techniques and formulae to support civil engineering projects: <b>(Core Ref: 7.1.1)</b><ul style="list-style-type: none"><li>○ practical construction problems involving perimeters, areas and volumes, including for simple and compound shapes:<ul style="list-style-type: none"><li>– rectangles</li><li>– trapeziums</li><li>– triangles</li><li>– prisms</li><li>– circles</li><li>– spheres</li><li>– pyramids</li><li>– cones</li><li>– regular and irregular surface areas and volumes</li></ul></li><li>○ mensuration formulae and numerical integration methods (mid-ordinate rule, trapezoidal rule, Simpson's rule) <b>(Core Ref: 7.2.3)</b></li><li>○ practical construction problems, including surveying, setting out, dimensions of pitched roof and similar:<ul style="list-style-type: none"><li>– geometric techniques to determine length, area and volume for shapes containing straight lines and curves <b>(Core Ref: 7.1.1)</b></li><li>– use of trigonometry to determine dimensions in 2D and 3D <b>(Core Ref: 7.1.3)</b></li></ul></li><li>○ trigonometric techniques:<ul style="list-style-type: none"><li>– sine rule</li><li>– cosine rule</li><li>– triangle area rules</li></ul></li></ul></li><li>● understanding the need for accuracy in calculations</li><li>● ability to select and apply statistical techniques correctly to solve practical construction problems <b>(Core Ref: 7.3.1)</b></li><li>● statistical techniques – processing large groups of data to achieve mean, median, mode and standard deviation, cumulative frequency, quartiles, quartile range, methods of visual presentation <b>(Core Ref: 7.3.1, 7.3.2)</b></li><li>● practical construction problems – use of graphs to solve construction problems; use of statistics to present data and make decisions based on statistical data</li><li>● relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams <b>(Core Ref: 7.3.1, 7.3.2, 7.3.3)</b></li></ul>
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	<ul style="list-style-type: none"> <li>determining the centroid of regular and irregular rectangular structural/engineering sections, including calculations of first moment of area, second moment of area, the parallel axis theorem and section modulus.</li> </ul>
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### What skills do students need to demonstrate?

**CES2.10** Use appropriate techniques to confirm validity of calculations.

**CES2.11** Model information, using appropriate digital software and other tools.

### What underpinning knowledge do students need?

**CEK2.13**

- Use techniques to confirm validity of calculations: **(E1)**
  - case studies
  - historic records
  - estimation methods
  - alternative calculation methods.

Use computer software and apply mathematical techniques to analyse beam and retaining wall load in order to verify manual solutions are correct, check solutions and model proposed design solutions: **(D1) (D3)**

- principles of moments and the laws of static equilibrium
- use of approximation/estimation techniques to check calculations
- use of computer software to analyse beam and retaining wall load to verify manual solutions are correct.

## Performance Outcome 3: Verify delivery of civil engineering solutions

### What skills do students need to demonstrate?

**CES3.1** Extract relevant information from provided sources.

### What underpinning knowledge do students need?

<b>CEK3.1</b>	<p>Justify how extracted relevant information from a civil engineering project has been applied to develop design solutions:</p> <ul style="list-style-type: none"> <li>● verify how structural elements, materials, beams, columns, frameworks and retaining walls behave under load</li> <li>● analyse structural elements under load to enable verification of structural elements</li> <li>● assess impact of chosen materials on structural elements: structural steel, masonry, timber, reinforced concrete.</li> </ul>
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### What skills do students need to demonstrate?

**CES3.2** Process geotechnical and structural behaviour and human factors information, and data related to the performance of a proposed solution.

### What underpinning knowledge do students need?

<b>CEK3.2</b>	<p>Justify proposed civil engineering solutions in terms of geotechnical and structural behaviour, human factors information and data: <b>(D1, D2, D3, D5)</b></p> <ul style="list-style-type: none"> <li>● geotechnical survey information, bore holes, trial pits; groundwater – water table, contamination, ground load bearing capacity, soil type; settlement and subsidence, soil shrinkage</li> <li>● earthwork design, excavation, cuttings, embankments, earth moving equipment and concreting equipment</li> <li>● information related to the behaviour of structural elements:             <ul style="list-style-type: none"> <li>○ beams in bending and shear</li> <li>○ stresses and deflection</li> <li>○ foundations</li> <li>○ columns and struts under direct load and eccentric load</li> <li>○ effect of restraint on members in compression</li> <li>○ retaining walls in relation to overturning, sliding and overstressing</li> </ul> </li> <li>● resource planning</li> <li>● labour management techniques (work and method study; control and organisation of labour)</li> <li>● plant management (hire, lease or purchase; utilisation and control)</li> </ul>
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- factors considered during the planning process that can have an impact on the planning outcomes:
  - labour factors:
    - availability and cost
    - skill levels
    - motivation
    - productivity
  - plant factors:
    - output rates
    - efficiency
  - material factors:
    - availability
    - delivery periods
    - lead times
    - design approval
    - site handling
    - waste
    - sustainability issues
  - community/stakeholder issues.
- structural behaviour of materials as a result of their properties, degradation and resistance to degradation, including corrosion, chemical degradation, embedded energy, recycling potential
- materials testing results
- structural testing results.

## What skills do students need to demonstrate?

**CES3.3** Interpret information and data, including from visual and other sources.

## What underpinning knowledge do students need?

<b>CEK3.3</b>	<p>Demonstrate interpretation of information and data to design civil engineering solutions, with labelled sketches, diagrams and supporting data – effect of different loading conditions and failure of, e.g. beams, columns, retaining walls, frames, struts and ties: <b>(E1, E2, E3, D1, D3)</b></p> <ul style="list-style-type: none"><li>● consideration of structural elements, loading and potential failure in analysis, design and verification</li><li>● use of special paints and protective coatings; use of sulphate resisting cement (SRC); importance of water/cement ratio</li><li>● materials – structural steel, masonry, timber, reinforced concrete</li><li>● loading, including point, uniform and wind loading</li><li>● types of failure – tension, compression, shear</li><li>● beams – point of contraflexure consideration; use and application of the bending theory equation; limit state design</li><li>● columns – safe axial design load, including allowance for eccentric loaded columns; limit state design</li><li>● retaining wall: factors of safety against sliding, overturning and overstressing; middle third rule</li><li>● frames: forces in members and if they are struts or ties.</li></ul> <p>Relationship between force (load), mass and acceleration:</p> <ul style="list-style-type: none"><li>● determine the centroid of regular and irregular rectangular structural/engineering sections; this should include calculations of first moment of area, second moment of area, the parallel axis theorem and section modulus</li><li>● coplanar forces; Hooke's law; loading, shear forces and bending moments of beams.</li></ul> <p>Rules of measurement and contractual implications (CESMM):</p> <ul style="list-style-type: none"><li>● financial implications of works not being priced correctly</li><li>● use of manual methods and their application to price the bill of quantities, produced in accordance with CESMM4 (Civil Engineering Standard Method of Measurement 4) to complete an estimate</li><li>● building up unit rates for measured work sections; selection of material price to use; use of coverage rates; use of appropriate wastage percentage; offloading and storage costs; use of 'all-in' labour rates; use of labour 'constants'; sundry plant requirements; addition of overheads and profits</li><li>● inclusion of subcontractor quotations – unit rates, lump sums, pricing attendance and special attendance, addition of overheads and profit</li><li>● completing PC sums and provisional sums (PS) – inclusion of PS and PC sums:<ul style="list-style-type: none"><li>○ addition for overheads and profit</li><li>○ addition for attendance and special attendance</li></ul></li><li>● inclusion of contingency sums</li><li>● pricing dayworks – labour, materials, plant</li></ul>
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|--|---|
|  | <ul style="list-style-type: none"><li>• pricing preliminary items – employer’s requirements; management and staff; security, safety and protection; site establishment and accommodation; temporary services; safety and environmental protection; fixed plant; scaffolding and temporary works; insurances, bonds, guarantees and warranties; allowance for fixed or fluctuating price</li><li>• use of computer software to verify manual solutions are correct</li><li>• types of measurement for the combination of data, cross checking and valuations</li><li>• value engineering techniques.</li></ul> |
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## What skills do students need to demonstrate?

**CES3.4** Complete technical reports.

## What underpinning knowledge do students need?

### **CEK3.4**

Demonstrate the ability to complete and present technical reports to a non-technical audience. Support the completion of technical reports with the use of digital software techniques. **(D1, D2, D3, D5)**

Digital design tools:

- types of digital presentation - PowerPoint, image handling and desktop publishing; brochures and reports
- production of design section, plan and detail sketches/drawings
- use of computer-aided design (CAD) to produce section, plan and detail drawings:
  - Autodesk AutoCAD, Autodesk AutoCAD LT, Autodesk Revit, Autodesk 3D Max, Autodesk Inventor
  - SolidWorks, Bentley MicroStation, ArchiCAD
  - SketchUp, CAD freeware
- production of a range of accurate scale construction drawings:
  - floor plans, detailed sections through whole buildings and of specific construction components (substructure, superstructure to eaves, roof and floors), elevation details
  - component drawings, site plans, block plans, isometric drawings
  - digital specification tools, e.g. the NBS, ISO 19650
  - digital data, e.g. spreadsheets and schedules
  - digital presentations, image handling and desktop publishing, e.g. brochures and reports.

Rationalise choices made when generating a developed proposition to improve an engineering product.

Understand industry valuation standards, guidance and practice, and how these are used to verify delivery of the built environment:

- objective referencing against product design specification/criteria
- objective referencing against weighted matrix
- indirect benefits and opportunities
- balancing benefits and opportunities with constraints (cost-benefit analysis, environmental benefits, health and safety risks, product life cycle considerations)
- design for manufacturing
- further modifications (technology-led adaptations).

### What skills do students need to demonstrate?

**CES3.5** Use digital engineering software with accuracy.

### What underpinning knowledge do students need?

<b>CEK3.5</b>	<p>Use digital engineering software with confidence and accuracy to verify structural design solutions. Use and present digital software solutions with accuracy for civil engineering projects. <b>(D1, D2, D3)</b></p> <p>Digital design tools:</p> <ul style="list-style-type: none"><li>● production of design section, plan and detail sketches/drawings</li><li>● use of computer-aided design (CAD) to produce section, plan and detail drawings:<ul style="list-style-type: none"><li>○ Autodesk AutoCAD, Autodesk AutoCAD LT, Autodesk Revit, Autodesk 3D Max, Autodesk Inventor</li><li>○ SolidWorks, Bentley MicroStation, ArchiCAD</li><li>○ SketchUp, CAD freeware</li></ul></li><li>● digital specification tools – the NBS, ISO 19650</li><li>● digital data – spreadsheets and schedules</li><li>● digital presentations, image handling and desktop publishing – brochures and reports.</li></ul>
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## What skills do students need to demonstrate?

**CES3.6** Complete costings analysis.

**CES3.7** Apply appropriate mathematical techniques to solve structural mechanics problems, including algebra, statistics, trigonometry, calculus.

## What underpinning knowledge do students need?

### **CEK3.6**

Verify mathematical calculations and costings analysis to support a construction project, e.g. calculations of irregular areas of land, cut and fill, use of trigonometry and geometric techniques to solve applied construction contextualised problems. Complete calculations of structural mechanics problems related to beam, column and retaining wall design to demonstrate understanding of how to analyse civil engineering structures.

Solve structural mechanics problems - reactive forces, maximum load:

- materials – structural steel, masonry, timber
- structural mechanics problems – relating to beams, columns, frames
- beams – point loads, uniformly distributed loads (UDLs), combined loads, reactions, shear force values, bending moment values, relationship between shear force and bending moment, point of contraflexure, simply supported beams with cantilever ends, simply supported beams without cantilever ends
- columns – axially loaded, eccentrically loaded, effective length, maximum stress
- frameworks: statically determinate, pin-jointed, subject to dead loads and wind loads.

Algebra, including indices, logarithms, linear equations:

- techniques and methods – mathematical operations, factorisation, expansion, transposition, substitution and elimination, rounding, decimal places, significant figures, approximation, truncation errors and accuracy, calculator functions and use, indices, logarithms
- formulae, equations and algebraic expressions – linear, simultaneous, quadratic equations
- solving algebraically or via graphic methods, simultaneous equations.

Trigonometric, geometric and standard formulae, including circular and triangular measures:

- ability to select and apply mathematical techniques correctly to solve practical construction problems involving perimeters, areas and volumes
- mathematical techniques: simple mensuration formulae and numerical integration methods (mid-ordinate rule, trapezoidal rule, Simpson's rule)
- practical construction problems involving perimeters, areas and volumes – calculations for simple and compound shapes (rectangles, trapeziums, triangles, prisms, circles, spheres, pyramids, cones) and regular and irregular surface areas and volumes
- ability to select and apply geometric and trigonometric techniques correctly to solve practical construction problems
- geometric techniques – properties of points, lines, angles, curves and planes, Pythagoras' theorem, radians, arc lengths and areas of sectors

- practical construction problems – geometric techniques to determine length, area and volume for shapes containing straight lines and curves; use of trigonometry to determine dimensions in 2D and 3D; surveying, setting out, dimensions of pitched roof and similar
- trigonometric techniques – sine, cosine, tangent ratios, sine rule, cosine rule, triangle area rules.

Elementary calculations and techniques including integration and differentiation:

- use of calculus to solve practical engineering problems
- differential calculus – basic differentiation techniques applied to algebraic, trigonometric and logarithmic functions, products and quotients; function of a function
- integral calculus – indefinite and definite integration techniques applied to algebraic, trigonometric and exponential functions.

Statistical methods including averages, tendency and dispersion:

- ability to select and apply statistical techniques correctly to solve practical construction problems
- statistical techniques – processing large groups of data to achieve mean, median, mode and standard deviation, cumulative frequency, quartiles, quartile range, methods of visual presentation
- practical construction problems – use of graphs to solve construction problems; use of statistics to present data and make decisions based on statistical data.
- Managing costs: selection and application of techniques available to break down, itemise and control the project cost, including:
  - unit costing
  - element costing
  - marginal costing
- variance analysis.

# Scheme of Assessment – Civil Engineering

There is a single synoptic assessment for the Occupational Specialist Component, which is an extended 'design, development and implementation' project. The synoptic element of the project is important in order to ensure that students are able to demonstrate threshold competence: this is the principal reason why the occupational specialism is assessed via a single extended project assessment to ensure that students are able to evidence all the skills required by the Performance Outcomes.

The mapping, timings and scheduling and preparation for assessment shown below are for the current specimen assessment material, the assessment will have the same overarching number of tasks and overall focus but the order of tasks and the detail within the task may change each series.

<b>Occupational Specialism assessment: Civil Engineering</b>
<b>Externally set project: 25 hours</b> <b>180 marks</b>
<b>Content overview</b> Students are required to: <ul style="list-style-type: none"><li>• analyse civil engineering solutions</li><li>• design civil engineering solutions</li><li>• verify delivery of civil engineering solutions.</li></ul>
<b>Assessment overview</b> This project will be externally set and marked by Pearson. Students will respond to a client brief to analyse information, design construction solutions and verify delivery of those construction solutions. The project will consist of a portfolio of evidence, including an observation report to evidence practical skills to meet threshold competence where appropriate. This will be accompanied by video evidence. The project will show students demonstrating the following tasks: <b>Task 1: Project analysis</b> Students will produce an analysis of the proposed project, considering potential risks and commercial viability, and performing calculations to support their report. <b>Task 2: Report on structural detail</b> Students will produce a report that explores the choice of structural form for the proposed building works and support this with sketch details. <b>Task 3: Column and beam design with related mathematics</b> Students will produce designs for beams and columns showing calculations and structural mechanics diagrams. Students will perform calculations that relate to their design. <b>Task 4: Design an external works component of the project including CAD drawing details</b> Students will produce draft designs showing their calculations and CAD design. They will then refine their designs using software.

## Occupational Specialism assessment: Civil Engineering

### **Task 5: External works presentation and risk assessment**

Students will produce a presentation that explores a proposal for an aspect of the external works that needs to take place on site. They will produce an accompanying risk assessment.

### **Task 6: Practical setting out**

Students will undertake a setting-out task where they will be required to accurately set out two points according to the measurements given in the project brief.

### **Task 7: Tender and price comparison**

Students will use a spreadsheet to complete an analysis comparing the original tender price of one aspect of the construction with the final account figures. They will provide commentary on variations, the reasons for changes in cost and any recommendations.

### **Task 8: Quality assurance and data analysis**

Students will quality assure a testing process and carry out analysis of test results associated with this process.

### **Administration**

Providers must follow the guidance in the following:

- General Administrative Support Guide
- Administration Support Guide for the specific Technical Qualification Employer Set Project (if applicable)

These are located on the [Training and Admin Support webpage](#).

## Timings and scheduling

Task	Assessment Session	Assessment scheduling	Time
<b>Task 1</b>	1	Taken in a single session at a time specified by Pearson.	3h 0m
<b>Task 2</b>	2	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	3h 0m
<b>Task 3a</b>	3	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	3h 0m
<b>Task 3b</b>	4	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	2h 0m
<b>Task 4</b>	5	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	2h 0m
<b>Task 5</b>	6	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	3h 0m
<b>Task 6</b>	7	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	2h 0m
<b>Task 7</b>	8	Taken in a single session at a time specified by Pearson.	2h 0m
<b>Task 8</b>	9	Taken in a single session at a time specified by Pearson.	3h 0m

The Construction: Design, Surveying and Planning Occupational Specialist Component project consists of a number of activities grouped into a number of substantive tasks.

Each task will be completed during a window set by Pearson, during which you will schedule supervised assessment sessions. In some cases, tasks will also involve opportunities for unsupervised assessment, where the requirements of the skills being assessed make this necessary.

Performance Outcome		Weighting	
		Raw marks	% of total marks
PO1	Analyse civil engineering solutions	70.2	39%
PO2	Design civil engineering solutions	70.2	39%
PO3	Verify delivery of civil engineering solutions	39.6	22%

## Preparation for assessment

Students will submit evidence for tasks in either hard copy or electronic/digital format. Where an electronic/digital submission is made, students need access to computers and the appropriate software. A summary of the submission requirements for each task is given below.

Task	Evidence type
1	Hard copy submission: report and supporting calculations.
2	Hard copy submission: written report and supporting sketch details.
3a	Hard copy: calculations and design diagrams.
3b	Hard copy: calculations.
4	Hard copy submission: civil engineering design and CAD drawings.
5	Digital submission: presentation slides and speaker notes, proposal and risk assessment.
6	Digital submission: observation form and video.
7	Digital submission: costing sheets and written report.
8	Hard copy submission: answer booklet with quality assurance, analysis and report.

A summary of preparation work that providers need to carry out before assessments take place is given below.

Task	Preparation work required
Task 6	Providers will need to source a site of a suitable size to carry out a practical task.



## 3. Building Services Design

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### Content Summary

The content is separated into three Performance Outcomes, with the skills needed to achieve threshold competence and the knowledge to underpin skill application across the following areas. Where skills are linked to knowledge in the Core Component these are indicated, for example 8.5.3).

### Performance Outcome 1: Analyse building services solutions

#### What skills do students need to demonstrate?

##### **BSDS1.1 Analyse information to determine requirements of the task.**

- Analysis of a range of information, including:
  - Plans  
**(Core Ref: 5.3.3)**
  - specifications
  - maintenance records
  - performance data
  - site and other constraints.
- Review of existing or proposed site.
- Further surveys and tests required to determine the full scope of the task.
- Understanding of information from a variety of sources to understand the existing performance of building services engineering systems, to set the design parameters for a new installation and to verify that a new system is meeting the design parameters:  
**(Core Ref: 5.3.3)**
  - test data
  - charts
  - tables
  - drawings to understand existing performance or design requirements.

##### **BSDS1.2 Gather required information.**

- Identify the information required.
- Identify what information is available and where it can be found.
- Identify how to gather information that is not available and make requests to third parties, or instigate or undertake surveys.
- Use correct survey equipment and techniques to capture information and data for building service engineering projects.  
**(Core Ref: 3.2.1)**
- Understand and comply with relevant health and safety requirements when undertaking surveys.

### **BSDS1.3 Sequence and prioritise individual tasks.**

- Identify, understand and use project management techniques that could be adopted into the solutions of the project and to present ideas and information: **(D1/E2)**  
**(Core Ref: 13.3.2)**
  - resource planning
  - bar charts
  - Gantt diagrams
  - critical path analysis  
**(Core Ref: 9.9.4)**
  - use of BIM.

### **BSDS1.5 Process data, using appropriate techniques.**

Understand what data may be required for a specific purpose in a project at each stage, and be able to extract and present this through:

- sorting
- reordering
- manipulating
- carrying out calculations to enable appropriate information to be determined from data.

**(Core Ref: 7.3.1)**

Understand how data can be presented to an audience using presentation techniques, with a variety of media:

**(Core Ref: 7.3.1)**

- ways of classifying data and information  
**(Core Ref: 7.3.2)**
- ways that data can be presented.

### **BSDS1.4 Interpret information and data, including from visual and other sources.**

### **BSDS1.6 Analyse and convey data, using appropriate techniques.**

### **BSDS1.7 Calculate data required for design.**

**Calculate, analyse and convey data, using appropriate techniques, in respect of the current provisions/services. (BSDS1.4, BDS1.6, BDS1.7)**

Understand the tools available to present information on current building services engineering installations to a variety of audiences.

Conduct calculations for the design of a typical building services engineering installation:

- analyse information **(E5)**
- select the information to be presented in a given situation **(E3)**
- understand how this can be put into a form understood by the audience
- understand ways to present data – sketches, drawings, tables, charts, graphs, results of calculations and photographs  
**(Core Ref: 8.5.1)**
- digital forms of presentation – podcasts, PowerPoint digital brochures, CAD drawings.  
**(Core Ref: 8.5.2)**

## What underpinning knowledge do students need?

**BDSK1.1**

### **Health and safety**

**Key requirements, roles and responsibilities associated with health and safety legislation, and**

### **Legal health and safety obligations of existing installations**

Understand how key legislation relates to the role of a Building Services Design Technician, to assist engineers and other construction professionals to provide design solutions:

- Gas Safety (Installation and Use) (Amendment) Regulations 2018:
  - purpose – for anyone involved in installation, service, repair or maintenance of gas appliances and other gas fittings
  - the qualifications required of people working on gas installations and appliances
- Gas Safety (Management) Regulations 1996
- Electricity at Work Regulations 1989, BS 7671 – Wiring Regulations, ‘Requirements for Electrical Installations’, IET Wiring Regulations.
- non-statutory regulations that ‘relate principally to the design, selection, erection, inspection and testing of electrical installations, whether permanent or temporary, in and about buildings generally and to agricultural and horticultural premises, construction sites’
- health and safety at work legislation:  
**(Core Ref: 1.1.1)**
  - duties of employers, employees
  - the Health and Safety Executive (HSE) and others  
**(Core Ref: 1.3.1)**
  - general prohibitions.
- current Personal Protective Equipment (PPE) at Work Regulations:
  - types of PPE
  - assessing suitable PPE given the hazard
  - supply of instructions/training
  - correct use
  - maintenance and storage
- building regulations  
**(Core Ref: 4.3.1)**
- Control of Noise at Work Regulations 2005
- Control of Asbestos Regulations 2012
- Legionnaires disease. The control of legionnaires bacteria in water systems (HSE publication)
- Control of Substances Hazardous to Health Regulations (COSHH) 2002:  
**(Core Ref: 1.1.2)**
  - identifying harmful substances
  - assessing risks of exposure
  - types of exposure
  - safety data sheets
  - using/checking/maintaining control measures/equipment
  - training/instruction/information.

<b>BDSK1.2</b>	<p><b>Sustainability</b></p> <p>Sustainability methods and techniques used in the design of modern construction projects and in the refurbishment, remodelling and extension of existing buildings, and how they can reduce pollution and the impact on the environment.</p> <p><b>K1.2.1 Key requirements, roles and responsibilities associated with environmental protection legislation</b></p> <ul style="list-style-type: none"> <li>● Environmental Protection Act 1990: <ul style="list-style-type: none"> <li>○ waste management, waste transporting, hazardous waste, recycling and safe disposal <b>(Core Ref: 8.2.4)</b></li> <li>○ emissions, reduction through alternative energy, high- and low- embodied materials. <b>(Core Ref: 9.2.4)</b></li> </ul> </li> <li>● Environment Act 1995: <ul style="list-style-type: none"> <li>○ enforcement via the Environment Agency</li> <li>○ other enforcement bodies.</li> </ul> </li> <li>● Water Resources Act 1991: <ul style="list-style-type: none"> <li>○ the protection of underground, rivers and coastal water from pollution.</li> </ul> </li> </ul> <p><b>K1.2.2 Financial incentives</b></p> <ul style="list-style-type: none"> <li>● Taxes and how they may reduce carbon footprint: <ul style="list-style-type: none"> <li>○ climate change levy</li> <li>○ CRC Energy Efficiency Scheme</li> <li>○ emission trading</li> <li>○ capital allowance on energy-efficient items</li> <li>○ landfill tax</li> <li>○ aggregates levy.</li> </ul> </li> <li>● Life cycle costing: <ul style="list-style-type: none"> <li>○ technology solutions <b>(Core Ref: 8.4.1)</b></li> <li>○ selection of sustainable materials and components</li> <li>○ maintenance requirements</li> <li>○ running costs</li> <li>○ demolition and recycling.</li> </ul> </li> </ul> <p><b>K1.2.3 Environmental performance measures associated with building services systems</b></p> <ul style="list-style-type: none"> <li>● Use of Building Research Establishment Environmental Assessment Method (BREEAM) and the assessment process – sustainability assessment method for planning projects, infrastructure and buildings. <b>(Core Ref: 10.4.2)</b></li> </ul>
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- Categories:
  - management
  - energy
  - health and wellbeing
  - innovation
  - land use and ecology
  - materials
  - transport
  - pollution
  - waste
  - water.

**BDSK1.3**

**K1.3.1 SI units, including those associated with electricity, magnetism, measurement, energy, force, time and illumination**

Know the different SI units used in building services design, with their associated symbols and quantity.

SI Unit Name	Unit Notation	Quantity	In other SI units
<b>Radian</b>	rad	plane angle	
<b>Hertz</b>	Hz	frequency	
<b>Newton</b>	N	force, weight	
<b>Pascal</b>	Pa	pressure, stress	N/m <sup>2</sup>
<b>Joule</b>	J	energy, work, heat	N·m = Pa·m <sup>3</sup>
<b>Watt</b>	W	power, radiant flux	J/s
<b>Coulomb</b>	C	electric charge or quantity of electricity	
<b>Volt</b>	V	voltage (electrical potential), emf	W/A
<b>Farad</b>	F	capacitance	C/V
<b>Ohm</b>	Ω	resistance, impedance, reactance	V/A
<b>Weber</b>	Wb	magnetic flux	V·s
<b>Tesla</b>	T	magnetic flux density	Wb/m <sup>2</sup>
<b>Henry</b>	H	inductance	Wb/A
<b>degree Celsius</b>	°C	temperature relative to 273.15 K	

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	<p><b>K1.3.2 Derived SI units, including those associated with area, volume, weight, energy and force.</b> (Core Ref: 3.2.1)</p> <p>Know the different SI derived units used in building services design, with their associated symbols and quantity.</p> <table border="1"> <thead> <tr> <th>SI Derived unit Name</th> <th>Unit Notation</th> <th>Quantity</th> <th>Symbol</th> </tr> </thead> <tbody> <tr> <td><b>square metre</b></td> <td>m<sup>2</sup></td> <td>area</td> <td>A</td> </tr> <tr> <td><b>cubic metre</b></td> <td>m<sup>3</sup></td> <td>volume</td> <td>V</td> </tr> <tr> <td><b>metre per second</b></td> <td>m·s<sup>-1</sup></td> <td>speed, velocity</td> <td>v</td> </tr> <tr> <td><b>metre per second squared</b></td> <td>m·s<sup>-2</sup></td> <td>acceleration</td> <td>a</td> </tr> <tr> <td><b>reciprocal metre</b></td> <td>m<sup>-1</sup></td> <td>wavenumber</td> <td>σ, <math>\tilde{\nu}</math></td> </tr> <tr> <td><b>kilogram per cubic metre</b></td> <td>kg·m<sup>-3</sup></td> <td>density</td> <td>ρ</td> </tr> <tr> <td><b>kilogram per square metre</b></td> <td>kg·m<sup>-2</sup></td> <td>surface density</td> <td>ρ<sub>A</sub></td> </tr> <tr> <td><b>cubic metre per kilogram</b></td> <td>m<sup>3</sup>·kg<sup>-1</sup></td> <td>specific volume</td> <td>V</td> </tr> <tr> <td><b>ampere per square metre</b></td> <td>A·m<sup>-2</sup></td> <td>current density</td> <td>J</td> </tr> <tr> <td><b>candela per square metre</b></td> <td>cd·m<sup>-2</sup></td> <td>luminance</td> <td>L<sub>v</sub></td> </tr> </tbody> </table>	SI Derived unit Name	Unit Notation	Quantity	Symbol	<b>square metre</b>	m <sup>2</sup>	area	A	<b>cubic metre</b>	m <sup>3</sup>	volume	V	<b>metre per second</b>	m·s <sup>-1</sup>	speed, velocity	v	<b>metre per second squared</b>	m·s <sup>-2</sup>	acceleration	a	<b>reciprocal metre</b>	m <sup>-1</sup>	wavenumber	σ, $\tilde{\nu}$	<b>kilogram per cubic metre</b>	kg·m <sup>-3</sup>	density	ρ	<b>kilogram per square metre</b>	kg·m <sup>-2</sup>	surface density	ρ <sub>A</sub>	<b>cubic metre per kilogram</b>	m <sup>3</sup> ·kg <sup>-1</sup>	specific volume	V	<b>ampere per square metre</b>	A·m <sup>-2</sup>	current density	J	<b>candela per square metre</b>	cd·m <sup>-2</sup>	luminance	L <sub>v</sub>
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	<p><b>K1.3.3 Gas laws, including Charles's law, Boyle's law</b></p> <p>Ideal gases and their application to building services engineering – the principles and calculations of gases and their impact on the design and performance of installations and equipment:</p> <ul style="list-style-type: none"> <li>• the volume of a sample of a gas being inversely proportional to its pressure</li> <li>• relationship of pressure to temperature, volume, mass.</li> <li>• application of general gas law, including systems under pressure</li> <li>• application of characteristic gas equations to solve problems related to building services science</li> <li>• application of Dalton's law (<math>P_{total} = P_1 + P_2 + \dots + P_n</math>) to solve problems involving multiple pressures.</li> </ul>																																												

### **K1.3.4 Electrical systems and properties**

The standard units that are used in electrical systems, what they measure and their interrelationships.

- Basic electrical quantities:

**(Core Ref: 2.4.2)**

- charge
- AC
- DC
- current
- voltage
- resistance
- conductance
- reactance
- frequency
- standard symbols and their abbreviations.

Calculations and their use within electrical circuits and installations.

**(Core Ref: 2.4.5)**

- Calculation of electrical power.
- Electrical energy.
- Electrical charge.
- Use of material resistivity to determine the resistance of materials in relation to length and cross-sectional area.
- Basic laws:  
**(Core Ref: 2.4.2)**
  - Ohm's law
  - Faraday's law
  - Lenz's law.
- Determination of values of resistance, voltage, current and power in series, parallel and combination circuits for DC.
- AC wave form.
- Power in AC and DC circuits, root mean squared (RMS).
- Resistance in AC circuits.

Electrical science calculations and applications.

**(Core Ref: 2.4.5)**

- Calculations to determine:
  - magnetic flux
  - flux density
  - induced emf
  - electrostatic field strength for capacitors
  - energy stored in inductor
  - back emf
  - self-inductance  
**(Core Ref: 2.4.3)**
  - mutual inductance.
- Service head: ownership.

- Cut out: ownership and purpose.
- Meter: ownership and purpose.
- Consumer unit: types, purpose, isolation.
- Current density: density of current in an electrical conductor, measured in A/cm<sup>2</sup>.
- Current: the flow of electrical energy.
- Electromagnetic field: force associated with electric charge in motion.
- AC circuits:
  - capacitance
  - inductance
  - reactance
  - imaginary impedance
  - mutual inductance.
- **(Core Ref: 2.4.3)**
- Load: calculation of electrical energy used.
- No-load consumption: calculation of energy loss when not on load, resistance of insulation.
- Parasitic consumption: calculation of load in standby, wasted energy.
- On-grid: a domestic dwelling that is connected to the national 230V AC supply grid.
- Protected circuit: an electrical circuit protected against fire.
- Supply-side: the generation, transmission and distribution of electricity up to and including the domestic meter.
- **(Core Ref: 2.4.4)**
- System: selection of cables and outlets for the load required.
- Single-phase supplies.
- Three-phase supplies.
- Efficacy: calculation of light output, lumens per watt (lm/W).
- **(Core Ref: 2.6.5)**
- Demand-side: a general term referring to everything that consumes electricity.

The statutory and non-statutory measures that should be met and implemented in the design of electrical installations, and their benefits and drawbacks.

- Electricity at Work Regulations (EWR) 1989.
- British Standards BS 7671 Requirements for Electrical Installations, on-site guide and guidance notes:
  - building regulations
  - Electrical Installation Condition Report (EICR)
  - permit to work.
- Special locations within BS 7671.



- Test methods and requirements, including their purpose:
  - sequence of tests:
    - visual inspection
    - continuity of CPC
    - continuity of ring final circuit
    - insulation resistance, polarity (dead then live),  $Z_s$  is earth fault loop impedance,  $Z_e$  at the origin (Prospective Fault Current is a calculation)
    - residual current device (RCD)
    - functional testing.
- Certification.
- Operation and maintenance manuals.

Earthing and bonding – the statutory measures that must be met in the design of electrical installations, and their impact on electrical safety.

- Earthing principles and TN-S, TN-CS and TT systems:
  - shock protection
  - principles of earthing
  - protective conductors
  - earth and ground rod.
- Bonding requirements and methods:
  - main
  - supplementary bonding
  - equipotential bonding.

Final circuits and circuit protection – the safety devices that must be incorporated within the consumer unit in the design of electrical installations, and the benefits that they provide.

- Breaker and circuit breakers (CB).
- Miniature circuit breaker (MCB).
- Residual current device (RCD).
- Residual current circuit breaker (RCCB).
- Residual current circuit breaker with overcurrent protection (RCBO).

### **K1.3.5 Mechanical properties, systems and units**

Understand the properties and units, and their application on systems.

- Mechanical properties:  
**(Core Ref: 2.1.1)**
  - strength (tensile, shear, compressive)
  - hardness
  - toughness
  - ductility
  - malleability
  - elasticity
  - brittleness.
- Systems and units:  
**(Core Ref: 3.2.1)**
  - latent heat
  - capillary action

- velocity
- ductility
- malleability
- force
- pressure
- flow rates
- dynamic pressure
- humidity
- atmospheric pressure
- conduction  
**(Core Ref: 2.5.1)**
- convection  
**(Core Ref: 2.5.1)**
- heat transfer  
**(Core Ref: 2.5.6)**
- heat losses  
**(Core Ref: 2.5.4/5)**
- stack effects.

#### **K1.3.6 Strength, including tensile, compressive, shear**

Understand how strength of materials is a consideration in Building services design

- Yield (or proof strength): stress needed to produce a specified amount of plastic or permanent deformation. (Usually a 0.2 % change in length.)  
**(Core Ref: 2.3.2)**
- Ultimate tensile strength (UTS): the maximum stress a material can withstand before fracture.
- The relationship between stress and strain (load and elongation):
- stress = load/original cross sectional area  
**(Core Ref: 2.3.2)**
- strain = change in length under load/original length.
- The difference between compressive and tensile strength.  
**(Core Ref: 2.3.1)**
- Shear.

Understand properties, modes of failure, protection and lubrication of building services engineering materials and components that impact on their selection when designing an engineering product, including:

- mechanical properties  
**(Core Ref: 2.1.1)**
- physical properties
- thermal properties
- electrical and magnetic properties and behaviour of advanced materials (bio materials, smart alloys, nanoengineered materials)
- modes of failure
- surface treatments and coating  
**(Core Ref: 2.1.1)**
- lubrication (purposes, regimes).

### **K1.3.7 Thermodynamics, including laws, material science, phase transition**

Understand the laws of thermodynamics and how it relates to the work of a building services design technician to support design solutions.

- Laws for thermodynamics.
- Thermodynamic properties and processes:
  - relationship between pressure, saturation temperature and enthalpy
  - thermodynamic properties for water and refrigerants
  - identification and interpretation of various zones of a pressure-enthalpy (P-H) diagram, to include:
    - sub-cooled liquid
    - latent heat
    - super-heated vapour
    - saturated liquid
    - saturated vapour.
- Graphical representation of thermodynamic processes:
  - isothermal evaporation
  - adiabatic compression
  - simple vapour compression
  - refrigeration cycles.
- Use of tables and P-H diagrams to obtain values in solving problems, to include:
  - saturation temperature and enthalpy of dry saturated vapour at  $n$  bar pressure
  - enthalpy at  $n$  bar pressure with  $x$  degrees of superheat
  - refrigeration plant and equipment.
- Changes of state:
  - kinetic theory of matter
  - reasons for change of state, to include changes in temperature, changes in pressure
  - sensible and latent heat, to include latent heat of fusion, latent heat of vaporisation
  - application of the theory of enthalpy to solve problems where change of state occurs and latent heat is encountered.
- Air conditioning systems and refrigeration:
  - air conditioning processes and cycles
  - psychrometric terms and properties of air and water vapour, to include calculation, measurement, tables, charts
  - psychrometric process lines, to include:
    - sensible heating and cooling
    - dehumidification and humidification (using different types of humidifiers)
    - resulting condition from mixture of two air streams.

- Plotting summer and winter psychrometric cycles for given arrangements of air-conditioning plant and operating conditions, to include:
  - heater batteries
  - cooler batteries (operating in sensible cooling and dehumidification mode)
  - humidification, to include steam, adiabatic, humidity ratio, relative humidity
  - air-mixing applications.
- Determine plant duties from psychrometric chart.

### **K1.3.8 Building technology**

#### **Properties of materials used in building services engineering.**

How the properties' of materials impact on the installation of building services.

- Definition of material properties and how materials are used in building services engineering:
  - creep resistance  
**(Core Ref: 2.1.1)**
  - elasticity/stiffness
  - fatigue strength and endurance limit
  - toughness
  - hardness
  - acoustics
  - pH
  - permeability
  - castability
  - brittleness
  - durability
  - flexibility
  - resilience
  - size, viscosity
  - boiling point
  - flammability
  - flash point
  - melting point
  - thermal conductivity
  - vapour pressure
  - corrosion in metals
  - oxidation.
- Key properties of construction materials, how they work together to provide composite performance and properties, how they impact on performance in use and on the specification of materials for different scenarios and levels of exposure to the elements:  
**(Core Ref: 2.1.2)**
  - Bricks, concrete, concrete blocks, plasterboard, glass and glass finishes, insulation materials, plastics, timber, engineered timber and manufactured board, roofing materials, metals

	<p><b>K1.3.9 Combustion</b></p> <p>Know the type of combustion and factors such as fuel air ratio, efficiency and products of combustion.</p> <ul style="list-style-type: none"> <li>● Incomplete combustion.</li> <li>● Stoichiometric.</li> <li>● Fuels, solid, liquid, gas.</li> <li>● Flash point.</li> <li>● Smouldering.</li> <li>● Diffusion.</li> <li>● Rapid.</li> <li>● Spontaneous.</li> <li>● Flue draft, ventilation.</li> </ul>
<p><b>BSDK1.4</b></p>	<p><b>Building structures</b></p> <p><b>K1.4.1 Purpose, importance and types of flues and chimneys</b></p> <p>Purpose of flues and chimneys – to vent products of combustion.</p> <ul style="list-style-type: none"> <li>● Types of flue/chimney: <ul style="list-style-type: none"> <li>○ open</li> <li>○ closed</li> <li>○ balanced</li> <li>○ power.</li> </ul> </li> <li>● The design and materials of flues for different fuels.</li> <li>● Ventilation requirements.</li> <li>● Commissioning.</li> <li>● Regulations that apply to flues.</li> <li>● Scientific concepts and principles, and their application to building services systems.</li> </ul>
<p><b>BSDK1.5</b></p>	<p><b>Principles of building services engineering systems</b></p> <p><b>K1.5.1 Types of system, their purposes, similarities and differences in operation. Mechanical and electrotechnical components, mechanical, electrical and plumbing components, their characteristic, function within the system and implications for the systems of component failure.</b></p> <p>Understand the purpose of building services engineering systems in buildings and know how systems operate to understand similarities and differences.</p> <p><b>Cold water (mains, stored)</b></p> <p>The practices associated with the provision of cold-water systems. The systems used to supply buildings with potable cold water for drinking, flushing toilets, bathing, laundry and to feed heating systems, and the situations in which each system would be appropriate.</p>

- Direct cold-water systems:
  - distribution to buildings:
    - service pipe minimum of 750 mm below ground
    - pipe to pass through wall above foundations
    - pipe to be sealed at entrance to wall
    - first 600 mm of pipe to be insulated
    - stop valve
    - rising main to drinking water tap
    - storage cistern
  - internal layout of system, to include:
    - direct supply to all outlets
    - requirement for low-capacity cistern to feed a hot water storage cylinder if installed
    - annotated line diagram for the layout showing key components
  - selection of materials used, dimensions and capacities:
    - externally – 22 mm diameter service pipe, generally plastic (blue polyethylene or uPVC), although copper is acceptable
    - internally – copper or plastic pipes (generally 15 mm diameter, 20 mm for baths),
    - 115-litre feed cistern (with 22 mm diameter overflow and feed to copper hot water)
    - storage cylinder (if installed), cisterns made from polyethylene, polypropylene or polyvinyl chloride (galvanised steel in older systems)
  - situations where system is appropriate:
    - where water pressure is high or where drinking water is required from all outlets; inappropriate when supply is cut off or reduced
    - in periods of peak demand, or where there is a danger of back-siphonage.
- Indirect cold water systems:
  - internal layout of system, to include:
    - cold water supplied to all outlets (except the sink) from a cold water storage cistern
    - sink connected directly to rising main for supply of potable water
    - annotated line diagram for the layout showing key components.
- Selection of materials used, dimensions and capacities, to include:
  - copper or plastic pipes (generally 15 mm diameter, 20 mm for bath), 115-litre feed
  - cistern (with 22 mm diameter overflow and feed to minimum 140-litre copper hot water storage cylinder (if installed), 230-litre cisterns in polyethylene
  - polypropylene or polyvinyl chloride (galvanised steel in older systems)
  - situations where system is appropriate, to include where a reserve is required
  - should supply be cut off or reduced, where there is a risk of back-siphonage.

### **Hot water (direct, indirect)**

The practices associated with the provision of hot water systems. The systems used to supply buildings with cold water to feed heating systems, including the provision of hot water, and the situations in which each system would be appropriate.

- Direct hot-water systems:
  - mains pressure systems, to include combi boilers
  - traditional systems, to include water heated in boiler, rises by convection to hot water
  - storage cylinder, replaced by colder water from bottom of storage cylinder, hot water drawn from storage cylinder is replaced with cold water from cistern
  - selection of materials used, dimensions and capacities to include copper pipes (28 mm)
  - diameter primary feed from boiler to hot water cylinder, 22 mm diameter cold feed from cistern to hot water cylinder, 22 mm for hot water supply to bath (otherwise 15 mm diameter), minimum 140-litre hot water cylinder, 230-litre cold water cistern
  - situations where system is appropriate, to include in soft water areas and where there is no associated central heating circuit.
- Indirect hot-water systems:
  - mains pressure system using pressure vessels
  - traditional system similar to direct system but with a separate small-capacity-feed cistern to charge and top up the primary circuit
  - hot water storage cylinder as a heat exchanger providing heat for secondary circuit from which hot water is drawn
  - selection of materials used, dimensions and capacities:
    - as for direct systems plus 36-litre plastic feed and expansion cistern
    - situations where system is appropriate, to include hard water areas and systems with associated central heating circuits.

### **Drainage**

Above-ground drainage

- The design of above-ground drainage systems, to include:
  - need for water seal
  - reduction of siphonage effect
  - provision of ventilation
  - fall for the waste pipes.

Above-ground drainage approaches

- Single-stack and two-pipe systems designed to prevent siphoning and discharge of gases.
- Single-stack and two-pipe systems, to include:
  - single-stack, to include waste from washbasins, sinks, baths and WCs, feeds into single 100-mm vertical waste pipe, vented to outside above the roof line
  - all appliances have U-bend trap full of water (exceptions may be kitchen sink and cloakroom WC)

- two-pipe system, to include older properties only, WC waste fed into a large-bore soil pipe, leading directly to sewage network, remaining waste waters from washbasins, bath and kitchen sink are combined and led to a gully just below ground level.
- Selection of layout, materials used, dimensions and falls, to include:
  - all in uPVC or polypropylene
  - 100-mm diameter soil and vent pipe (SVP)
  - appliances connected separately into the stack to prevent induced and self-siphonage
  - limits on the length and levels of branch connections
  - all branch pipes to have 50 mm sweep into SVP
  - compliance with regulatory requirements
  - annotated line diagram for the layout showing key components.

#### Below-ground drainage

- The design of below-ground drainage systems, to include:
  - capacity
  - fall for self-cleansing flow
  - ventilation
  - support
  - avoidance of leakage
  - access at every change in gradient (inspection chambers, manholes, rodding points)
  - pipe size or bend
  - minimisation of pipe runs
  - all junctions oblique and in direction of flow.

#### Below-ground drainage approaches

- Separate systems used for surface and foul water as the standard modern method, to include:
  - separate systems used for surface and foul water where surface water and foul water are conveyed in separate drains and sewers
  - surface water requires no treatment before final outfall.
- Combined systems for surface and foul water where surface water and foul water are both conveyed in the same drain and sewer, to include:
  - entire effluent requires treatment
  - simpler and cheaper to construct, but more expensive to operate
  - a traditional approach not preferred in new constructions.
- Selection of layout, materials used, dimensions, falls and capacities:
  - rigid pipes, to include vitrified clay, concrete, cast iron
  - flexible pipes, to include uPVC, polyethylene, ductile iron, glass-reinforced plastic
  - appropriate falls for surface water and foul water drainage
  - appropriate bedding materials for pipes and surrounds
  - annotated line diagram for the layout showing key components.



**Space cooling**

- Air-conditioning systems and refrigeration:
  - air-conditioning processes and cycles
  - psychrometric terms and properties of air and water vapour, to include calculation, measurement, tables, charts
  - psychrometric process lines, to include
    - sensible heating and cooling
    - dehumidification and humidification (using different types of humidifiers)
    - resulting condition from mixture of two air streams.

**Ventilation – extract fans/indoor air quality**

The consideration and selection of appropriate ventilation and air-conditioning plant, equipment and materials.

**Air-terminal devices**

The use of air-terminal devices to control the flow of air to ensure a comfortable environment for building users and stakeholders.

- Installation requirements and application of supply and extract air-terminal devices:
  - characteristics
  - terminology
  - operational features
  - materials.
- Control of air quality and direction of air discharge in supply and extract devices:
  - operational features
  - installation requirements
  - materials
  - suction dynamics, to include booths, canopies, hoods and other extraction devices
  - used in commercial kitchens and industrial applications, to include grease filters
  - grease removal and fire prevention in kitchen canopies.

**Ductwork, jointing and systems**

The characteristics and selection of appropriate ductwork materials and related service components.

- Ductwork shapes and materials used for heating, ventilation and air-conditioning (HVAC) systems.
- Support systems.
- Characteristics and features of jointing:
  - assembly
  - installation procedures.
- Relationship between physical properties of ductwork materials and their application.
- Flexible and fire-rated ductwork.
- Criteria for selection of materials and shape.
- Published standards and specifications for ductwork.

- Ancillary components:
  - characteristics
  - operational features and selection criteria of various types of ductwork items, to include:
    - volume-control dampers
    - fire and smoke dampers
    - access doors
    - flexible connectors
    - test points.

### **Air-handling units**

The different elements of air-handling units and plant, including reasons for their use and the benefits that they provide for the building users and stakeholders.

- Air-handling plant:
  - types of fan, to include characteristics, operational features and applications of fans
  - types of drive
  - installation requirements and ductwork connections.
- Heater/cooler batteries:
  - types, material characteristics, operational features and applications of
    - heater batteries
    - chilled water and direct expansion (DX) cooling coils, to include installation requirements and ductwork connections.
- Heat-recovery devices:
  - types of heat-recovery device
  - characteristics, operational features and application of heat-recovery devices, to include installation requirements and ductwork connections.
- Air-cleaning devices:
  - terminology and definitions associated with filters and air-cleaning devices
  - group and class of filters
  - filter testing methods
  - type, characteristics, operational features and applications of filters and dust
  - collection/removal devices for air-handling systems, to include installation
    - requirements and ductwork connections.
- Humidifiers:
  - types of humidifier
  - characteristics, operational features and applications of humidifiers, to include:
    - installation requirements and ductwork connections
    - water supply
    - maintenance
    - health and safety implications of humidifiers.

- Refrigeration plant:
  - principles, components and application of vapour-compression refrigeration systems
  - application of refrigeration in air-conditioning systems
  - operation, features and applications of heat pumps.
- Air-handling units:
  - configuration and features of simple units, to include:
    - composite air-handling units (AHUs)
    - local exhaust ventilation systems
    - dust collection
    - packaged air-conditioning systems
  - control requirement and arrangements for ventilation and warm air-handling installations.

### **Heating**

The selection of a heat emitter, including the assessment of output requirements in meeting the design parameters.

- Radiators, to include panel, sectional, low surface temperature, compact.
- Towel rails.
- Underfloor heating
  - size of heat emitters required for comfortable temperature, taking into account the floor area and volume of the space being heated
  - heat losses associated with the area and volume being heated
  - size versus available space
  - aesthetics of emitter
  - heat output and efficiency
  - positioning and access for servicing.
- Boilers – the selection of an appropriate boiler to meet the design parameters of:
  - maintaining effective flow rates
  - efficiency for Part L of the Building Regulations
  - reduction in CO<sub>2</sub> emissions output required
  - operating costs
  - type of available fuels
  - combustion and ventilation requirements
  - capacity for future expansion
  - positioning and access for servicing
  - combination condensing systems
  - system boilers
  - traditional/conventional boiler – vented
  - biomass fuel boilers.
- Pipework circuits – design of circuits that are efficient in terms of the delivery of hot water to the discharge point or tap:
  - pipe-sizing calculations
  - flow rates required
  - friction losses

- maintaining a balanced system
- use of secondary returns
- means of isolation for maintenance purposes
- requirements for zoning of systems.
- The characteristics of the materials and components that will be used to carry hot water efficiently:
  - materials selection
    - plastic
    - copper.
- Type of jointing method:
  - soldered
  - push fit
  - crimped
  - compression.
- Pumps – the selection of a pump to meet the design parameters of:
  - sizing of pumps for volumes to be moved
  - pump margin and duty
  - selection in balancing design against availability
  - pump efficiency
  - reliability
  - lifespan
  - pump maintenance
  - positioning and access for servicing
  - use of valves to allow easy replacement.
- Expansion vessels – the selection of appropriate expansion vessels to meet the system's requirements:
  - size and capacity in maintaining flow rates for heat distribution
  - anticipated thermal expansion
  - location in the installation
  - means of pressure adjustment.
- Access and maintenance components, accounting within the design for access to valves, radiators, boilers, pipework for maintenance and adaptation, to include consideration of thermal expansion:
  - air bleeding of system either manually or automatically
  - position of boiler for ventilation and combustion requirements
  - position of boiler flue
  - combustion air-flow requirements
  - access panels to valves.

### **Electrical installations**

- The principles of the provision of simple, single-phase electrical systems:
  - a typical circuit to include the following components:
    - mains isolation switches, to include main service fuse, meter, main switch
    - consumer control unit, to include residual current devices (RCD), miniature circuit breakers (MCB) or fuses
    - earth connectors
    - socket outlets
    - electrical accessories.
- Ring circuits for a maximum permissible floor area:
  - circuits, to include:
    - line conductor and neutral conductor
    - CPC looped from socket to socket
    - protected by 32 amperes (A) fuse or miniature circuit breaker
  - socket outlets, to include individual as well as spur outlets:
    - individual socket outlets to accept fused appliances up to 13 A
    - unlimited number of socket outlets
    - spur outlets not to exceed number of primary outlets
    - maximum of two outlets per spur.
- Radial circuits – radial circuits for lighting and individual high-power appliances:
  - lighting, to include loop-in method using earthed twin cable
  - individual high-power appliances, to include electric cookers, showers, water heaters, protected up to 45 A, depending on power taken by appliance.

### **Components and applications**

- Components – their use and behaviour in electrical and electronic circuits used in building services engineering:
  - electrical conductors
  - electrical insulators
  - cells
  - generators
  - resistors
  - capacitors and capacitance
  - inductors and inductance
  - thermocouples
  - use of AC and DC.
- Transformers.
  - Operating principles of single-phase transformer.
  - Transformer construction.
  - Transformer ratings.
  - Circuit equivalent of a transformer.
- Transformer regulation, including:
  - iron losses, copper losses and eddy-current losses.
- Transformer efficiency.
- No-load and on-load phasor diagrams.

- Types of transformer:
  - small power
  - large power
  - auto
  - three-phase
  - current and voltage transformers.
- Transformer cooling methods.
- Calculations to apply transformer, to specify transformers and determine efficiency.
- Practical applications of transformers:
  - step-up voltage and current  
**(Core Ref: 2.4.3)**
  - step-down voltage and current  
**(Core Ref: 2.4.3)**
  - to isolate
  - to measure voltage and current.

### **Earthing and bonding**

- The statutory measures that must be met in the design of electrical installations and their impact on electrical safety:
  - earthing principles:
    - protection against electric shock
    - protective conductors
    - earth and ground rod.
  - bonding requirements and methods:
    - main
    - supplementary bonding
    - equipotential bonding.
- Final circuits and circuit protection:
  - the safety devices that must be incorporated in the consumer unit and the design of electrical installations, and the benefits they provide:
    - breaker and circuit breakers (CB)
    - miniature circuit breaker (MCB)
    - residual current device (RCD)
    - residual current circuit breaker with overcurrent protection (RCBO).
- Wiring methods and techniques – the types of cable, wiring and electrical system that need to be considered and specified in an electrical installation and how this is achieved:
  - cable type:
    - meter tails
    - twin (2, 3 and 4) core and earth
    - live (L)
    - neutral (N)
    - earth (E)
    - steel-wire armoured (SWA)
    - flexible cords
    - powerlines

- the characteristics of the material and components that will be used to carry and distribute electricity safely:
  - materials selection
  - earthing and bonding
  - size of cable
    - § 1 mm<sup>2</sup> PVC insulated twin and earth (1 mm<sup>2</sup>, 1.5 mm<sup>2</sup>, 2.5 mm<sup>2</sup>, 6 mm<sup>2</sup>, 10 mm<sup>2</sup>)
    - § 1.5 mm<sup>2</sup> 3-core and earth
    - § 1.5 mm<sup>2</sup> earth
    - § 25 mm<sup>2</sup> meter tails
- power outlets:
  - fused spur
  - switched fused spur
  - junction boxes
  - cooker points
  - external sockets
  - built-in USB chargers
  - shaving points
- switches:
  - pull chord
  - single pole
  - switched stairway lighting
  - dimmers
- lighting:
  - IP ratings
  - fire protection for down lighters
  - light-emitting diode (LED) under cabinet and kickboard lighting
  - security
  - garden lighting.
- Opportunities for smart (i.e. internet enabled) and wireless control interfaces/systems to be appropriate for greater convenience and energy efficiency for the consumer.  
**(Core Ref: 6.1.3)**

**Design of a building services engineering system that meets the client brief**

Wiring – design of an electrical installation for a property, with due consideration that demand and power requirements are safe.

Power requirements – key elements to consider in circuit design for construction projects.

- Location of distribution board and equipment.
- Suitable circuit arrangements.
- Cables and wiring systems.
- Current carrying capacity.
- Number and location of socket outlets and other power loads.
- Cable routing.
- Wiring methods and techniques:
  - the types of cable, wiring and electrical system that need to be considered and specified in an electrical installation and how this is achieved

- cable type:
  - meter tails
  - twin (2, 3 and 4) core and earth
  - live (L)
  - neutral (N)
  - earth (E)
  - steel-wire armoured (SWA)
  - flexible cords
  - powerlines
- wiring systems:
  - final radial and loop
  - ring final circuit (RFC)
  - spur
  - floor area limits for each circuit
  - 12 V down lights and transformers
  - smoke and fire alarms
  - intruder
  - data and communications
  - bathroom extraction isolation
  - central heating systems, to include boiler control panels, thermostats, underfloor heating
- cable protection:
  - PVC and sheathed
  - trunking metal and plastic
- voltage drop
- cable capacity
- current capacity and cable sizing:
  - ring main
  - showers
  - immersion heaters
  - cookers
  - night-storage heaters electric bathroom towel heaters
  - lighting.
- Automatic disconnection of supply (BS7671).
- The selection of luminaires to meet user requirements and standards, including the assessment of output levels to meet design requirements and to fulfil legal parameters, to include:
  - lamps and luminaires
  - cables and wiring systems
  - switching arrangements:
    - one way
    - two way
    - intermediate
  - lighting zones:
    - ingress protection (IP rating)
    - cable routing
    - illumination levels
    - glare rating inverse square law of illumination
    - cosine law of illumination



- lumen calculation for the number of luminaires for artificial light installations
- spacing ratios
- glare assessment and prevention.

- Design meets performance requirements.
- Proposed design is within available budget.

**K1.5.2 Types of control system, their purposes, components, similarities and, differences**

Digital signal processors (DSP) takes real-world signals, such as voice, audio, video, temperature, pressure or position, that have been digitised. The use of digital signal processors (DSP) in the control of building services systems.

Understand the principles associated with building services control systems

- The working principles of control systems to provide effective control of the internal environment of the building, providing appropriate comfort levels for the end user.

Understand control loops

- How control loops are used in control systems, the benefits and drawbacks of each type, including how inputs, decisions and outputs interrelate:
  - open loop
  - closed loop
  - single loop
  - multi loop.

**Modes of control**

- Main modes of control and their uses, including the advantages and drawbacks for a range of situations:
  - two position
  - proportional
  - integral
  - derivative
  - proportional-integral (PI)
  - proportional-integral-derivative (PID).

**Purpose of control systems**

- The use and benefits provided by building services control systems for building users and other stakeholders:
  - how building services are controlled and impact on the stakeholder's comfort and use of the building
  - consequences of poor control
  - effects for the building owner and environment
  - legislative requirements.
- Apply the principles of building services control systems and the function and operational characteristics of control systems.
- The purpose of controls systems, their operational characteristics and the effects of poor control systems on the environment.

	<p><b>K5.3 Monitoring systems</b></p> <ul style="list-style-type: none"> <li>• Types of system: (Core Ref: 6.1.4, 6.1.5) <ul style="list-style-type: none"> <li>○ digital</li> <li>○ analogue.</li> </ul> </li> <li>• How they collect and transmit data.</li> </ul>
<p><b>BSDK1.6</b></p>	<p><b>Understand sources of information used in the analysis, design and verification of building services engineering, their content and purposes, and the digital applications to record and present information. The different sources of information – visual forms – to present information and data:</b></p> <ul style="list-style-type: none"> <li>• drawings – BS1192 (Core Ref: 8.5.1)</li> <li>• charts</li> <li>• graphs</li> <li>• diagrams</li> <li>• information and data sources: (Core Ref: 5.3.3) <ul style="list-style-type: none"> <li>○ manufacturers’ – brochures, data sheets, specifications, operating manuals and guides</li> <li>○ client records – maintenance reports, logs</li> <li>○ third-party sources – utility companies, planning authority</li> <li>○ specifications – NBS (Core Ref: 4.3.1)</li> <li>○ legislation – Building Regulations, health, safety and welfare, gas and electrical regulations</li> <li>○ survey data</li> <li>○ digital applications</li> <li>○ data resulting from analysis</li> <li>○ data resulting from design</li> <li>○ data resulting from commissioning and operation</li> <li>○ conventions (Core Ref: 8.5.3)</li> <li>○ symbols.</li> </ul> </li> </ul>

## Performance Outcome 2: Design building services

\*Please refer to the knowledge content BDSK1.4 Scientific concepts and principles and their application to building services systems, in Performance Outcome 1. This knowledge is also underpinning knowledge for Performance Outcome 2.

### What skills do students need to demonstrate?

#### **BSDS2.1 Explore requirements of the task, using open questioning and listening.**

- Identify which questions should be asked of a client to assist with the understanding of a task and, depending on the response, what follow-up questions should be asked. (This could be demonstrated through students listening to a recording and providing written questions.) **(E1, E2)**
- Using questioning to seek information.
- Building systems:
  - ventilation
  - air conditioning/cooling
  - plumbing
  - drainage
  - hot water supply
  - cold water supply
  - heating
  - electrical supply
  - lighting
  - mechanical services
- Use communication software to communicate with others: **(D1, E3)**
  - email
  - instant messaging
  - social media
  - video conferencing.

#### **BSDS2.2 Use appropriate data and information.**

- Be able to carry out the design of a building services engineering system that meets the client brief.
- Be able to convey technical information to colleagues, with rationale for decisions made for design: **(E1)**
  - for chosen building services equipment
  - using sketches and supporting notes.
- Ensure proposed design meets performance requirements.
- Carry out costing.
- Ensure proposed design is within available budget.

## What underpinning knowledge do students need?

### BSDK2.1

### Construction and the built environment industry

#### K2.1.1 Planning permission and building regulations relating to all notifiable works

Planning application processes – law and procedures used to apply for and obtain planning permission, and processes for appeal if permission is refused or conditions have been attached; the systems used when planning law is not observed.

- When permission would be required.
- When permission would not be required.
- How legislation relates to planning permissions and building regulations for notifiable works:
  - Town and Country Planning Act 1990
  - Town and Country Planning (Use Classes) Order 1987
  - case law and legal precedent.
- Permitted development:
  - types
  - limitations.
- Stages in the planning application process:
  - application forms
  - data and information required – Environmental Impact Assessment (EIA), including purpose, legislation, stages and Schedule 2 developments, land use and traffic surveys
  - fees to be paid.

The requirements of building regulations: the specifics of the Building Act 1984 and building regulations, and how to find and use the relevant information to support building services design solutions.

- Application of the Building Act 1984.
- The requirements of the Building Act 1984:
  - definition of building work and the extent of the building regulations application
  - material alterations
  - exemptions to the regulations
  - dispensation or relaxation of the regulations.

Approved documents.

- A basic knowledge of the approved documents, how to use them and how to meet the requirements:
  - fire safety, covered in Approved Document B
  - ventilation, covered in Approved Document F
  - sanitation, hot water safety and water efficiency, covered in Approved Document G
  - drainage and waste disposal, covered in Approved Document H

	<ul style="list-style-type: none"> <li>○ combustion appliances and fuel storage systems, covered in Approved Document J</li> <li>○ conservation of fuel and power, covered in Approved Document L</li> <li>○ electrical safety, covered in Approved Document P.</li> </ul>
<b>BSDK2.2</b>	<p><b>Design</b></p> <p><b>K2.2.1 How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes</b></p> <p>The construction design process.</p> <ul style="list-style-type: none"> <li>● Stages and tasks involved in the design process.</li> <li>● The application of Stages 1–4 of the Royal Institute of British Architects (RIBA) Plan of Work 2013 to the tasks associated with the design of low- and medium-rise domestic, commercial and industrial buildings: <ul style="list-style-type: none"> <li>○ preparation and brief</li> <li>○ concept design</li> <li>○ developed design</li> <li>○ technical design.</li> </ul> </li> </ul> <p>Factors that influence the design process.</p> <ul style="list-style-type: none"> <li>● Requirements and constraints, and their impact on the initial project brief and design process for combinations of rural, urban, greenfield and brownfield settings: <ul style="list-style-type: none"> <li>○ client requirements for the project outcomes</li> <li>○ building use, including domestic, industrial, commercial, retail, health, cultural and recreation; how the building operates within its defined use</li> <li>○ the project's spatial requirements – building size, layout, circulation space, number of floors, number and use of rooms</li> <li>○ flexibility and remodelling potential</li> <li>○ future extension potential to meet residential needs and business expansion</li> <li>○ external and internal aesthetics, types and use of materials</li> <li>○ sustainability, energy efficiency, alternative types of energy source</li> <li>○ age demographic of building user(s); needs of different building users.</li> </ul> </li> </ul> <p>Site information and constraints:</p> <ul style="list-style-type: none"> <li>● site features – location, size, configuration, orientation, access, topography</li> <li>● building services availability</li> <li>● existing buildings and structures</li> <li>● existing underground services.</li> </ul> <p>Planning constraints:</p> <ul style="list-style-type: none"> <li>● planning consent/approval</li> <li>● avoidance of air, water and noise pollution</li> <li>● the findings of Environmental Impact Assessments (EIAs) and their use in developing designs for a project.</li> </ul> <p>Project budget and economic constraints:</p> <ul style="list-style-type: none"> <li>● cost planning</li> <li>● available funds</li> <li>● life cycle costs.</li> </ul>

	<p><b>K2.2.2 The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent</b></p> <p>Initial project brief:</p> <ul style="list-style-type: none"> <li>● The initial project brief's purpose and its application.</li> <li>● Content of an initial project brief: <ul style="list-style-type: none"> <li>○ spatial requirements</li> <li>○ desired project outcomes</li> <li>○ site information</li> <li>○ budget requirements</li> <li>○ preliminary programme.</li> </ul> </li> <li>● Use of an initial project brief to generate and develop design ideas and specifications.</li> <li>● Completion of an initial project brief.</li> <li>● Use of appropriate tone and technical language for the target audience to communicate the design intent.</li> </ul>
	<p><b>K2.2.3 The implications of statutory obligations to designs</b></p> <p>The definition of statutory obligations and how they apply to:</p> <ul style="list-style-type: none"> <li>● planning and building regulations</li> <li>● health and safety</li> <li>● environment and pollution</li> <li>● noise.</li> </ul>
	<p><b>K2.2.4 The use and importance of specifications</b></p> <p>The purpose and application of specifications to building services engineering design, construction and operation.</p> <ul style="list-style-type: none"> <li>● Prescriptive and performance specifications, and the source of specifications for: <ul style="list-style-type: none"> <li>○ materials</li> <li>○ components</li> <li>○ design process</li> <li>○ workmanship.</li> </ul> </li> <li>· Importance of specifications – compliance, detail of design.</li> </ul>
	<p><b>K2.2.5 The relevance of measurement in the design process</b></p> <p>How measurements are made, and their importance to building services engineering design:</p> <ul style="list-style-type: none"> <li>● selection and use of measuring equipment</li> <li>● accuracy of measuring equipment</li> <li>● human error</li> <li>● effect on the design process and specification of plant and equipment</li> <li>● effect on the placing and fixing of plant and equipment.</li> </ul> <p>Types of measurement:</p> <ul style="list-style-type: none"> <li>● area (net and gross) volume, height and length.</li> </ul>

## What skills do students need to demonstrate?

### **BSDS2.3 Conduct precedent research, including best practice, benchmarks and design guides.**

Understand the range of information that needs to be collected and considered in the design of a building services engineering project:

- information on existing plant and equipment
- survey information
- design proposals for new building works
- appropriate design guides, standards and codes of practice for the services to be designed
- information on recent, similar designs to enable benchmarking.

### **BSDS2.4 Quality assure provided data.**

Review provided data against other sources of data to confirm accuracy and reliability:

- observations
- survey information
- test data.

### **BSDS2.5 Plan logistics, including life cycle, costing, maintenance and installation.**

Understand how to prepare a plan for the life cycle of a building, including the life cycle cost, from the installation of the plant to demolition:

- installation of plant and equipment
- commissioning
- operating
- running costs
- routine maintenance
- replacement.

Development of schedules for clients and colleagues, using different sources of information and data, and synthesising the information to support decision-making: **(E2/E5)**

- servicing
- maintenance
- replacements.

### **BSDS2.6 Apply appropriate mathematical techniques in a construction context.**

Understand appropriate mensuration techniques in design calculations, take-off and costing calculations for building services plant and equipment, to calculate regular areas, volumes and quantities of materials, using the correct units.

### **BSDS2.7 Model design, using digital software and other tools.**

Understand and use software to produce building service layout drawings and communicate/confirm design decisions: **(D2)**

- computer-aided design (CAD) – software used to produce highly detailed technical drawings (E1)
- BIM in modelling designs, to show conflict of building elements in design
- other appropriate computer software.

**BSDS2.8 Present appropriate design information and data, using different methods and formats.**

Understand how to present design information for building services engineering systems for a range of uses, including:

- project planning
- production of quantities
- selecting plant, equipment and materials.

Understand the different ways of presenting information:

- drawings – layout details or wiring diagrams, with correct annotation and labelling
- schedules of plant, equipment and materials, with appropriate details of each
- commissioning sheets, with the design parameters to be confirmed through testing or observation
- computer software to present design information. **(D1)**

**BSDS2.9 Enter data into digital engineering software.**

Know how to enter the correct data to:

- design software, including spreadsheets, to enable the design of building services plant, equipment or materials (D1)
- plant and equipment software driven controllers.

**BSDS2.10 Provide creative solutions to challenges arising from requirements.**

Understand how to be able to deal with building services engineering system situations, where a straightforward solution is not immediately obvious, but through independent thought a solution to the problem is found. This may include, but is not limited to:

- equipment and plant selection
- materials selection
- control system selection

Be able to synthesise information to support design decision-making: **(E5)**

- from the client
- historical data/surveys
- pre-surveys.

Be able to summarise ideas/information about designs and present them to others. **(E4/E2)**

Be able to create text for different purposes and audiences, including clients and colleagues. **(E3)**

**BSDS2.11 Adapt design proposals in response to design constraints and stakeholder feedback in terms of time, cost and material factors.**

Understand that alternative solutions may be available to meet a building services engineering problem.

The reasons for a solution to be adapted may include, but are not limited to:

- client feedback – cost, aesthetics, operating requirements
- building constraints – available space for plant rooms, loading capacity, layout, position of structural members
- planning constraints – external equipment and plan, noise.



## What underpinning knowledge do students need?

**BSDK2.3**

### **Health and safety**

#### **2.3.1 Responsibilities and legal health and safety implications of designs**

Understand why relevant administration and management tasks must be carried out to ensure that a construction site is a safe place of work:

- Adhere to The Construction (Design and Management) Regulations 2015 – improve health and safety in the industry:
  - the duties of the designer, the identification of hazards and risks at design stage, and methods of assessment, e.g. Design Risk
  - sensibly plan the work so the risks involved are managed from start to finish
  - have the right people for the right job at the right time
  - cooperate and coordinate your work with others
  - have the right information about the risks and how they are being managed
  - communicate this information effectively to those who need to know
  - consult and engage with workers about the risks and how they are being managed.
  - Assessments
  - further development of risk assessments, including for changing design, site or weather conditions
  - risks through the whole life cycle of the development – design, procurement, construction, operation, decommissioning
- Ensure maintenance of plant/equipment is carried out.
- Consider building life cycle.
- Health and safety preparation:
  - client to appoint Principal Designer
  - notifications to HSE, completion of F10 documentation
  - health and safety construction phase plan – contents and safe systems of work (SSW)
  - preparation of site induction content, inclusions, method of delivery
  - preparation of the site waste management plan, its content and specific requirements
  - safety poster provision, gate and entrance signage and notices, formal gate notifications
  - construction phase health and safety
  - delivery of site inductions and retaining records of inductions
  - identifying hazards by various methods – direct observation, checklists, audits, toolbox talks, safety committees
  - writing risk assessments and evaluating control measures – risk ratings, acceptable levels
  - writing method statements, sequencing of statements, resources to be used

- delivering toolbox talks – method, timing, what to cover in talk, who should be present
- issuing care and maintenance of personal protective equipment (PPE) and first-aid facilities
- preparing temporary fire and evacuation procedures
- instructing on waste disposal, segregation, good housekeeping
- managing subcontractors' safety information, site meetings.
- Health and safety file:
  - preparing file contents in accordance with the requirements of the Construction (Design and Management) Regulations 2015:
    - residual hazards that remain and how they have been dealt with – information concerning asbestos, contaminated land, buried services
    - key structural information – bracing, sources of substantial stored energy, including pre- or post-tensioned members
    - safe working loads for floors and roofs, particularly where these may prohibit placing scaffolding or heavy machinery
    - hazardous materials used, including manufacturers' data sheets – pesticides, special coatings that should not be burnt off
    - information regarding the removal or dismantling of installed plant and equipment – any special arrangements for lifting, special instructions for dismantling
    - health and safety information about equipment provided for cleaning or maintaining the structure
    - the nature, location and markings of significant services, including underground cables, gas supply equipment, firefighting services
    - information and as-built drawings of the structure, its plant and equipment – the means of safe access to and from service voids, fire doors and compartmentalisation
  - reviewing documentation
  - file distribution.
- Risk assessment for specific engineering processes, following guidance from the HSE, including:
  - identification of hazards
    - bad housekeeping
    - poor lighting
    - lack of grip/uneven surfaces/heights
    - lifting and handling operations
    - hand tools, machines
    - substances
    - heat/flammability
    - assessing risk by determining how hazards can cause injury – being struck, lifting and handling injury, falls, slips, trips, traps
    - using appropriate control measures and precautions to reduce risk – substitution, safe means of access and egress, safe systems of work (permits to work), periodic inspection, testing and maintenance, physical barriers (guarding), PPE, supervision and training, good housekeeping, cleaning regime
  - recording all findings
    - standard HSE (five steps)
    - reviewing the risk assessment after new equipment/work activities have been undertaken, at regular intervals.

<p><b>BSDK2.4</b></p>	<p><b>K2.4.1 Understanding mechanical, electrical and plumbing components (refer additionally to K5)</b></p> <p><b>Plumbing*</b></p> <p>Types of appliance:</p> <ul style="list-style-type: none"> <li>● washbasins</li> <li>● WCs</li> <li>● baths</li> <li>● bidets</li> <li>● shower valve arrangements</li> <li>● sinks</li> <li>● washing machines</li> <li>● dishwashers</li> <li>● fridges with water and ice dispensers</li> <li>● water boilers.</li> </ul>
<p><b>BSDK2.5</b></p>	<p><b>Digital technology</b></p> <p><b>K2.5.1 Specialist software and digital tools</b></p> <p>Specialist software for the design of building services installations: how the software can aid design, and the advantages and disadvantages.</p> <ul style="list-style-type: none"> <li>● Software may cover a range of disciplines such as: <ul style="list-style-type: none"> <li>○ 3D calculation of thermal conductivity to aid the design of building services in buildings</li> <li>○ heat-loss calculations</li> <li>○ heating system design</li> <li>○ electrical design</li> <li>○ lighting design.</li> </ul> </li> </ul>
<p><b>BSDK2.6</b></p>	<p><b>K2.6.1 Digital design tools</b></p> <p>How design tools can be used to produce different building services layout drawings.</p> <ul style="list-style-type: none"> <li>● Principles of building services engineering drawings: <ul style="list-style-type: none"> <li>○ attributes of orthographic projections, including: <ul style="list-style-type: none"> <li>– geometry – shape of the component represented as different views, how the component is viewed from various angles, visibility of component features</li> <li>– dimensions – size of the component in defined units</li> <li>– tolerances – allowable variations for defined dimensions</li> <li>– material – what the component is to be made from</li> <li>– surface texture – surface quality required, roughness, flatness</li> <li>– scale – relative to actual dimensions</li> </ul> </li> <li>○ drawing conventions or other relevant international equivalents, including: <ul style="list-style-type: none"> <li>– standards including BS 8888 and BS 60617 or other relevant international equivalents</li> <li>– title block/layout – drawing number(s), projection symbols, scale, units, general</li> <li>– tolerances, name of author, date, border, parts referencing</li> <li>– views – elevation, plan, end, section, hatching style, auxiliary</li> <li>– line types – centre, construction, outline, hidden, leader, dimension</li> </ul> </li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>– common features, including screw threads, springs, splines, repeated items, holes, chamfers, radii</li> <li>– circuit diagram symbols and components, including cell/battery, switch, resistor, diode</li> <li>– capacitors, transistors, integrated circuits, light-emitting diodes (LED), motors, buzzers</li> <li>– lettering – titles, notes, annotations</li> <li>– abbreviations – A/F, CHAM, DIA, R, PCD, M.</li> <li>– coordinates – absolute, relative, polar</li> <li>– drawing template – border, title block with all necessary information</li> <li>– layers – names, line types, colours, visibility</li> <li>– commands – line, circle, arc, polygon, chamfer, fillet, grid, snap, copy, rotate, erase</li> <li>– stretch, trim, scale, dimensioning, text, pan, zoom-in, zoom-out, insertion and editing</li> <li>– commands to produce and erase circuit components and connections</li> <li>– simple and complex areas, predefined hatch patterns, application to cross-sectioning, component libraries, saving in an appropriate format.</li> </ul>
<b>BSDK2.7</b>	<p><b>K2.7.1 Digital specification tools</b></p> <ul style="list-style-type: none"> <li>● BS 1192: 2007 collaborative production of architectural engineering and construction information, standard and convention requirements and their application to the different types of construction drawing.</li> <li>● The National Building Specification (NBS): <ul style="list-style-type: none"> <li>○ materials</li> <li>○ standards</li> <li>○ workmanship.</li> </ul> </li> </ul>
<b>BSDK2.8</b>	<p><b>K2.8.1 Digital data</b></p> <ul style="list-style-type: none"> <li>● The use of spreadsheets: <ul style="list-style-type: none"> <li>○ presentation of information in tables, charts and graphically</li> <li>○ extracting information</li> <li>○ the reordering, sorting and manipulation of data</li> <li>○ calculations</li> <li>○ storing data.</li> </ul> </li> <li>● Schedules: <ul style="list-style-type: none"> <li>○ extracting information from digital drawings</li> <li>○ extracting information from spreadsheets</li> <li>○ presenting information in the form of a list with associated details.</li> </ul> </li> </ul>
<b>BSDK2.9</b>	<p><b>K2.9.1 Digital presentations, image handling and desktop publishing</b></p> <ul style="list-style-type: none"> <li>● The use of digital software to present information: <ul style="list-style-type: none"> <li>○ CAD drawings</li> <li>○ AutoCAD walkthrough</li> <li>○ podcasts/screencasts</li> <li>○ digital reports</li> <li>○ desktop-published brochures.</li> </ul> </li> </ul>

## Performance Outcome 3: Verify delivery of building services solutions

\*Please refer to the knowledge content listed below for Performance Outcome 1. This knowledge is also underpinning knowledge for Performance Outcome 3.

### Performance Outcome 1

- BDSK1.3 Building technology
- BDSK1.4 Scientific concepts and principles and their application to building services systems
- BDSK1.4 Building structures
- BDSK1.5 Principles of building services engineering systems
- BDSK1.6 Sources of information, their content and purpose

#### What skills do students need to demonstrate?

##### **BSDS3.1 Collate information and data.**

Understand the appropriate information for build drawings:

- design data
- material specifications
- plant and equipment specifications
- maintenance and operating manuals
- commissioning test data
- certificates
- approval
- health and safety file
- maintenance schedules.

##### **BSDS3.2 Verify suitability of information and data from appropriate sources specific to the scope of works.**

Verify that information and data is valid for its intended purpose:

- site measurements – measurement of parameters to ensure they have been met
- site records – correct materials have been used
- delivery tickets – what materials have been delivered to site
- test results
- tests to check if systems are operating as specified.

Synthesise information to develop documentation for the servicing, maintenance and replacement of building service systems. **(E1, E5)**

##### **BSDS3.3 Interpret information and data, including from visual and other sources.**

Understand how the information from commissioning tests can be interpreted to confirm that the plant operates within design parameters. Data collected will include, but will not be limited to:

- commissioning tests
- pre-commissioning tests
- operating information – visual and data
- witness reports on system behaviour.

Synthesise information to develop documentation for the servicing, maintenance and replacement of building service systems. **(E1, E5)**

Create texts of synthesised information to create: **(E3)**

- reports
- spreadsheets
- CAD
- sketches.

**BSDS3.4 Use software with accuracy to verify specific items, utilising appropriate tools.**

Understand how to carry out calculations to the required degree of accuracy, using appropriate software, to verify that building services solutions have been installed and that they operate as designed and specified. Software may include but is not limited to:

- spreadsheets **(D1, D4)**
- specialist design packages **(D2)**
- CAD packages **(D2)**
- BIM.

**BSDS3.5 Complete costings analysis through, for example, spreadsheet software.**

Understand, using appropriate software, how to analyse the variances between individual items and parts of a bill of quantities from the original tendered bill of quantities, and the quantiles agreed in the final account of a project. **(D4)**

**BSDS3.6 Present information, using oral and written communication.**

Use digital software to present information:

- CAD drawings **(D2)**
- AutoCAD walkthrough **(D3)**
- podcasts/screencasts **(D3)**
- digital reports **(D1)**
- desktop-published brochures. **(D1)**

**What underpinning knowledge do students need?**

*(Content in italics refers to content that has already been delivered in the core but which is also required underpinning knowledge for the occupational specialism skills.)*

**BSDK3.1**

**K3.1.1 Industry valuation standards, guidance and practice, and how they are used to verify delivery of the built environment**

Rationalise choices made when generating a developed proposition to improve an engineering product, including:

- objective referencing against product design specification/criteria
- objective referencing against weighted matrix
- indirect benefits and opportunities
- balancing benefits and opportunities with constraints (cost-benefit analysis, environmental benefits, health and safety risks, product life cycle considerations)
- design for manufacturing
- further modifications (technology-led adaptations).

<b>BSDK3.2</b>	<p><b>K3.2.1 Valuation benchmarking and how it is used to verify delivery of the built environment</b></p> <ul style="list-style-type: none"> <li>• Technical audits to confirm design and outputs.</li> <li>• Comparison with similar projects.</li> </ul>
<b>BSDK3.3</b>	<p><b>K3.3.1 Types of measurement for the combined data</b></p> <p>Understand how to measure building services work for the purpose of producing valuations for accounts. This will include:</p> <ul style="list-style-type: none"> <li>• measured work – item, nr, m, m<sup>2</sup>, m<sup>3</sup></li> <li>• provisional and prime cost items</li> <li>• preliminaries</li> <li>• lump sums</li> <li>• dayworks.</li> </ul>
<b>BSDK3.4</b>	<p><b>Building technology</b></p> <p><b>K3.4.1 Suitability and operation of performance measurement equipment</b></p> <p>The different types of performance measurement equipment and how they work:</p> <ul style="list-style-type: none"> <li>• air quality: indoor air quality meter – water vapour, particulates, allergens, dust, toxic vapours and gases</li> <li>• noise levels: decibel meter – levels of sound</li> <li>• light levels: lux meter – luminance intensity.</li> </ul> <p><b>K3.4.2 Surveying techniques</b></p> <p>Understand the techniques used to carry out measurements and assess pipework and electrical circuits within building services engineering.</p> <ul style="list-style-type: none"> <li>• Instruments used to check flow rates and water pressure: <ul style="list-style-type: none"> <li>○ pressure gauges for static and kinetic pressure</li> <li>○ inline meters or volume per second rates for flowrates</li> <li>○ manometers for gas pressure – analogue and digital.</li> </ul> </li> <li>• Instruments used for checking, verifying and problem-solving within electrical circuits, and how and why they are used. <ul style="list-style-type: none"> <li>○ multimeter or separate meters – ohm meter, ammeter, voltmeter</li> <li>○ PAT testing equipment</li> <li>○ continuity testing</li> <li>○ non-contact voltage tester</li> <li>○ digital clamp meter</li> <li>○ multifunction tester.</li> </ul> </li> </ul>
<b>BSDK3.5</b>	<p><b>K3.5.1 Techniques for value engineering</b></p> <ul style="list-style-type: none"> <li>• Business analysis methods: <ul style="list-style-type: none"> <li>○ feasibility study methodology and approaches</li> <li>○ other feasibility and viability methods: <ul style="list-style-type: none"> <li>– PESTEL (political, economic, social, technological, environmental, legal) analysis</li> <li>– SWOT (strengths, weaknesses, opportunities, threats) analysis</li> <li>– 5 Cs (customer, company, competition, collaborators, context) analysis</li> <li>– Porter’s Five Forces</li> <li>– cost-benefit analysis.</li> </ul> </li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>● Residual method of valuation: <ul style="list-style-type: none"> <li>○ feasibility factors: <ul style="list-style-type: none"> <li>– changes in floor area, volume, elements price indices and use</li> <li>– availability of land, labour and finance</li> <li>– client requirements</li> <li>– planning and regeneration policy changes</li> <li>– legal and environmental requirements</li> <li>– specification standards</li> <li>– local property market and rental yield</li> <li>– client's approach/attitude to sustainability and the impact on the environment.</li> </ul> </li> </ul> </li> <li>● Modelling and testing of factors impacting on projects: <ul style="list-style-type: none"> <li>○ modelling and testing of current costs, opportunities and constraints</li> <li>○ modelling and testing of alternative scenarios</li> <li>○ forecasting and reporting techniques: <ul style="list-style-type: none"> <li>– cost forecasting, including cash flow, profit, return, cost and value</li> <li>– liquidity, including borrowing, working capital and profitability</li> <li>– use of software packages.</li> </ul> </li> </ul> </li> </ul>
<b>BSDK3.6</b>	<p><b>K3.6.1 Rules of measurement and contractual implications</b></p> <p>Standard methods of measurement – the use of the Standard Methods of Measurement (SMM) rules in the production of quantities.</p> <ul style="list-style-type: none"> <li>● Measurement rules: <ul style="list-style-type: none"> <li>○ the need for rules</li> <li>○ origins of measurement rules</li> <li>○ measurement initiative steering group</li> <li>○ status of the Royal Institution of Chartered Surveyors (RICS) New Rules of Measurement (NRM)</li> <li>○ status of the Institution of Civil Engineers (ICE) Civil Engineering Standard Method of Measurement (CESMM)</li> <li>○ typical considerations: <ul style="list-style-type: none"> <li>– units of measurement</li> <li>– deduction of voids</li> <li>– deemed to be included</li> <li>– item description</li> <li>– hierarchy of description</li> <li>– key content</li> <li>– preliminaries and measured work</li> <li>– guidance on the preparation of bills of quantities.</li> </ul> </li> </ul> </li> <li>● The New Rules of Measurement (NRM): <ul style="list-style-type: none"> <li>○ NRM 2 – detailed measurement for building works: <ul style="list-style-type: none"> <li>– application to taking off quantities for projects</li> <li>– uses of NRM 2</li> </ul> </li> <li>○ NRM 3 – order of cost estimating and cost planning for building maintenance works: <ul style="list-style-type: none"> <li>– application to maintaining projects</li> <li>– uses of NRM 3.</li> </ul> </li> </ul> </li> </ul>



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|--|--|
|  | <ul style="list-style-type: none"><li>• CESMM:<ul style="list-style-type: none"><li>○ content and its application to civil engineering projects</li><li>○ differences against the NRM volumes.</li></ul></li></ul> |
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## Scheme of Assessment – Building Services Design

There is a single synoptic assessment for the Occupational Specialist Component, which is an extended 'design, development and implementation' project. The synoptic element of the project is important in order to ensure that students are able to demonstrate threshold competence: this is the principal reason why the Occupational Specialism is assessed via a single extended project assessment to ensure that students are able to evidence all the skills required by the Performance Outcomes.

The mapping, timings and scheduling and preparation for assessment shown below are for the current specimen assessment material, the assessment will have the same overarching number of tasks and overall focus but the order of tasks and the detail within the task may change each series.

Occupational Specialism assessment: Building Services Design
<b>Externally assessed project: 20 hours 40 minutes</b> <b>180 marks</b>
<b>Content overview</b> Students are required to: <ul style="list-style-type: none"><li>• analyse building services solutions</li><li>• design building services solutions</li><li>• verify delivery of building services solutions.</li></ul> The building services that will be covered for this assessment consist of the following: <ul style="list-style-type: none"><li>• ventilation</li><li>• air conditioning/cooling</li><li>• drainage</li><li>• hot water supply</li><li>• cold water supply</li><li>• heating</li><li>• electrical supply</li><li>• lighting</li><li>• mechanical services.</li></ul>
<b>Assessment overview</b> This project will be set by Pearson and externally marked by Pearson. Students will respond to a client brief to analyse information, design building services solutions and verify delivery of the solutions. The project will show students implementing skills in tasks such as: <b>Task 1:</b> Students will analyse project information and make notes on information required for design calculations, stating where information can be sourced, quality assuring data and stating why information is required. Students will produce project management documentation using an appropriate IT package. Students will respond to a communication from the client, using a professional email requesting more information. <b>Task 2a:</b> Students complete design calculations related to the required information for the building service at hand.

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**Task 2b:** Students prepare design notes indicating and justifying the selection of components and justifying the overall design solution for the building service at hand.

**Task 2c:** Students use CAD to add the proposed elements of the designed solution for the relevant building service to the plans for the building.

**Task 3:** Students complete design calculations related to the required information for the building service at hand. Students design the solution for the relevant building service including producing annotated sketches indicating location of key components. Students prepare design notes detailing the rationale for the design of the relevant building service solution.

**Task 4:** Students design the solution for the relevant building service, including providing supporting calculations to justify the design as well as indicating components chosen for the proposed solution. Students consider how a variation to the requirements in relation to this service could be implemented and explain how this would impact on the design solution and components.

**Task 5:** Students produce a servicing, maintenance and replacement schedule over a period for one of the building services giving justifications for each item. Students review the commissioning documentation for one of the building services to identify completeness of the paperwork and installation along with remedial actions.

**Task 6a:** Students use a spreadsheet to complete an analysis comparing the original tender price of one of the building services with the final account figures. Students provide commentary on variations, the reasons for changes in cost and any recommendations.

**Task 6b:** Students produce a presentation summarising the findings of the price comparison analysis.

### Administration

Providers must follow the guidance in the following:

- General Administrative Support Guide
- Administration Support Guide for the specific Technical Qualification Employer Set Project (if applicable)

These are located on the [Training and Admin Support webpage](#).

## Timings and scheduling

Task	Assessment session	Assessment scheduling	Time
<b>Task 1</b>	1	Taken in a single session at a time specified by Pearson.	3h 0m
<b>Task 2a</b>	2	Taken on a day specified by Pearson, with all students beginning the task at the same time.	2h 0m
<b>Task 2b</b>	3	Taken on a day specified by Pearson, with all students beginning the task at the same time.	2h 0m
<b>Task 2c</b>	4	Completed in an individual student slot scheduled by the Provider within a one-week window.	1h 30m
<b>Task 3</b>	5	Taken in a single session at a time specified by Pearson.	3h 0m
<b>Task 4</b>	6	Completed in single slot scheduled by the Provider within a one-week window.	3h 0m
<b>Task 5</b>	7	Taken in a single session at a time specified by Pearson.	3h 0m
<b>Task 6a</b>	8	Taken in a single session at a time specified by Pearson.	3h 0m
<b>Task 6b</b>	9	Recording of a presentation, completed in an individual student slot scheduled by the Provider within a one-week window.	0h 10m (slot)

Performance Outcome		Weighting	
		Raw marks	% of total marks
PO1	Analyse building services solutions	45	25%
PO2	Design building services solutions	99	55%
PO3	Verify delivery of building services solutions	36	20%

## Preparation for assessment

Students will submit evidence for tasks in either hard copy or electronic/digital format. Where an electronic/digital submission is made, students need access to computers and the appropriate software. A summary of the submission requirements for each task is given below.

Task	Sub-task	Evidence type
1	a	Digital submission.
1	b	
2	a	Hard copy submission.
2	b	Hard copy submission.
2	c	Hard copy submission – CAD software.
3	a	Hard copy submission.
3	b	
3	c	
4	a	Hard copy submission.
4	b	
5	a	Hard copy submission.
5	b	
6	a	Digital submission – spreadsheet, word processing software.
6	b	Digital submission – presentation software and recording.

A summary of preparation work that providers need to carry out before assessments take place is given below.

Task	Preparation work required
<b>Task 6b</b>	Students will need access to audio equipment/screen casting equipment and will need to be able to record their presentation. They will need access to an appropriately quiet environment in which to complete their presentation recording.

# 5 Technical Qualification grading, T Level grading and results transfer

## How the Technical Qualification is graded and awarded

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### Calculation of the Technical Qualification grade

The Technical Qualification components are awarded at the grade ranges below.

Component	Available grade range
Core (including Core examination/s and Employer Set Project)	A* – E and Unclassified
Occupational Specialism	Distinction, Merit, Pass and Unclassified

The Core uses an aggregation of points from each of the Core assessments to calculate the A\* to E grade.

Students whose level of achievement for either component is below the minimum judged by Pearson to be of sufficient standard receive an unclassified (U) result.

### Awarding the components

Grade boundaries will be set for each component and/or sub-component (Core Examinations, Employer Set Project, and Occupational Specialism) in each series they are offered through a process known as awarding. Awarding is used to set grade boundaries and ensure standards are maintained over time. This is important as we must ensure students have the same opportunity to achieve, regardless of the assessment opportunity.

### Uniform Mark Scale

For the Core component, students' raw component and/or sub-component marks are converted to a Uniform Mark Scale (UMS). The UMS is used to convert students' 'raw' marks into uniform marks. This is done to benchmark outcomes from one series to another to account for any variety of in difficulty in assessments. For example, a student who produces a response worthy of a C grade in the Employer Set Project in one series will receive the same uniform mark as a student achieving that same grade and level of performance in another series, regardless of their raw marks.

The maximum number of uniform marks available for each sub-component, and the uniform marks relating to each grade boundary, are fixed. These are shown below.

Grade	Core Exam	Core ESP	Core Overall
<b>Maximum</b>	<b>240</b>	<b>120</b>	<b>360</b>
<b>A*</b>	216 – 240	108 – 120	324 – 360
<b>A</b>	192 – 215	96 – 107	288 – 323
<b>B</b>	168 – 191	84 – 95	252 – 287
<b>C</b>	144 – 167	72 – 83	216 – 251
<b>D</b>	120 – 143	60 – 71	180 – 215
<b>E</b>	96 – 119	48 – 59	144 – 179
<b>U</b>	0 – 95	0 – 47	0 – 143

Where the Core component has two Core Exams, the results are combined before conversion to UMS.

### Calculation of the T Level grade

The [T Level grade look-up table](#) shows the minimum thresholds the Department for Education use for calculating the T Level grade.

Students must complete both components and achieve a minimum of a grade E in the Core and a Pass in the Occupational Specialism. In addition, they must successfully complete the other elements of the T Level, such as the industry placement.

Students who do not meet the minimum requirements will not be certificated.

## Results transfer to Providers

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### Technical Qualification result days:

Assessment series	Results day
Summer	August (Level 3 Results Day)
November	March (normally the 3 <sup>rd</sup> week – Level 3 Results Day)

Pearson issues the results directly to you and make available:

- Scorecards: outlining the achievement in percentage terms against each Assessment Objective
- Results Plus: a service whereby achievement will be presented in an item-by-item format. This means Providers will be able to ascertain trends across and within cohorts, and clearly label the associated Assessment Objective
- Statement of Provisional Results: we will offer a provisional component result slip, clearly watermarked as a provisional component result.

As we are not required to issue Technical Qualification certificates, T Level certificates or T Level statements of achievement, we do not require you to complete any forms or processes to claim the Technical Qualification from Pearson.

### T Level Results reporting

The Department for Education will issue T Level results on Level 3 results day in August.

The Department for Education will provide T Level certificates to students who successfully complete all elements of the T Level.



# Appendix 1: General Competency Frameworks for T Levels

The General Competency Framework for T Levels articulates English, maths and digital competencies that students are required to develop over the course of the qualification. The tables below list the competencies from the framework that are relevant to the *T Level Technical Qualification in Design, Surveying and Planning for Construction*. The skills in grey are not relevant.

Competencies that can be developed in relation to a specification element of content are referenced in the column next to this content element in the occupational specialism. These competencies should be delivered through the content of this qualification and tutors should seek opportunities to allow students to develop the relevant skills to enable them to reach threshold competence in the specialism.

The English, maths and digital competencies are embedded in both the Core Component and the Occupational Specialist Component of the *T Level Technical Qualification in Design, Surveying and Planning for Construction*. This is so that students can demonstrate their knowledge and understanding of these skills over the course of the qualification.

## General English competencies

<b>E1</b>	Convey technical information to different audiences
<b>E2</b>	Present information and ideas
<b>E3</b>	Create texts for different purposes and audiences
<b>E4</b>	Summarise information/ideas
<b>E5</b>	Synthesise information
<b>E6</b>	Take part in/leading discussions

## General maths competencies

<b>M1</b>	Measure with precision
<b>M2</b>	Estimate, calculate and spot errors
<b>M3</b>	Work with proportion
<b>M4</b>	Use rules and formulae
<b>M5</b>	Process data
<b>M6</b>	Understand data and risk
<b>M7</b>	Interpret and represent with mathematical diagrams
<b>M8</b>	Communicate using mathematics
<b>M9</b>	Cost a project
<b>M10</b>	Optimise work processes

## General digital competencies

Students should be supported to develop the digital knowledge and skills needed in order to:

<b>D1</b>	Use digital technology and media effectively
<b>D2</b>	Design, create and edit documents and digital media
<b>D3</b>	Communicate and collaborate
<b>D4</b>	Process and analyse numerical data
<b>D5</b>	Be safe and responsible online

## Command word taxonomy list

The following table shows the command words that will be used consistently in our assessments to ensure students are rewarded for demonstrating the necessary skills. The list below will not necessarily be used in every paper and is provided for guidance only.

Command word	Definition	Mark tariffs
Assess	Give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something, and come to a conclusion where needed.	12 mark EOR LBMS descriptors provided must use these
Complete (diagram)	Complete a diagram or process flow that has already been started.	Up to 8 marks
Describe	Present two (or more) linked descriptive points on characteristics, features, uses or processes. Do not need to include a justification or reason.	1 mark per item
Discuss	Consider the different aspects in detail of an issue, situation, problem or argument, and how they interrelate.	6 mark EOR. LBMS descriptors provided – must use these
Draw	Produce a diagram, either using a ruler or using freehand OR create a graphical or visual representation of information.	Up to 8 marks
Evaluate	Consider various aspects of a subject's qualities in relation to its context such as: strengths or weaknesses, advantages or disadvantages. 9 mark questions will require you to come to a judgment supported by evidence which will often be in the form of a conclusion. 12 mark questions will require a comparative exercise involving at least two options, with a judgement supported by evidence which will often be in the form of a conclusion.	12 mark EOR LBMS descriptors provided – must use these
Explain	Present one point that identifies a reason, way or importance and a second point that justifies/explains the first point. Where used, a third point is a further justification/explanation.	2 or 4 marks. Max 2 marks per response. 2 mark – point (1) + justification (1) 4 mark – point (1) + justification (1) used twice

Command word	Definition	Mark tariffs
Give	Recall from memory a feature, characteristic or use.	1 mark per item
Identify	Select the correct answer from the given context or stimulus.	1 mark per item
List	Recall from memory facts, dates, legal implications, etc. More than one.	1 mark per item
State	Recall from memory a fact, date, legal implication, etc.	1 mark per item

# Appendix 2: Occupational Specialism Content Summaries

This document has been included for providers who delivered the T Level prior to 2025, where the previous specification included content summary pages for each occupational specialism with its own referencing system. From 2025 we have removed this from the main body of the specification to simplify and remove confusion. However, we have included this mapping below for centres who want to refer to that content summary for planning their teaching.

Note that content numbering/ references been updated for all the Occupational Specialisms from 2025.

## Occupational Specialism: Survey and Design for Construction and the Built Environment

Performance outcome	Ref#	Knowledge content	New Pearson ref#	Assessed under skill
<b>1: Measure the built environment</b>	<b>K1</b>	<b>Law</b>		
	K1.1	Permissions required to undertake survey work, including geospatial	SDK1.1	SDS1.1
	<b>K2</b>	<b>Digital technology</b>		
	K2.1	How the Internet of Things contributes to the measurement of the built environment	SDK1.2	SDS1.2
	K2.2	Geospatial equipment, their applications, suitability and use	SDK1.1 SDK1.2 SDK1.3	SDS1.1 SDS1.2 SDS1.3
	K2.3	Digital engineering techniques and appropriate software	SDK1.2 SDK1.3	SDS1.2 SDS1.3
	K2.4	Geospatial information conveyance and sourcing, including GIS, cartographic and other commercially available data	SDK1.2 SDK1.3	SDS1.2 SDS1.3
	<b>K3</b>	<b>Measurement</b>		
	K3.1	Types of measurement and detection	SDK1.4	SDS1.10
	K3.2	How to capture, process, manage, use and quality assure data, including geospatial	SDK1.4	SDS1.8 SDS1.9 SDS1.10

	K3.3	Calculations required and how to undertake them	SDK1.4	SDS1.8 SDS1.9 SDS1.10
	K3.4	The principles and limitations of measurement, e.g. parallax	SDK1.4	SDS1.8 SDS1.9 SDS1.10
	K3.5	Techniques used to gather data, including geospatial data, e.g. Global Navigation Satellite Systems (GNSS), photogrammetry	SDK1.4	SDS1.10
	K3.6	The importance of coordinating systems, projects, transformations and datums	SDK1.3 SDK1.4	SDS1.3 SDS1.10
	K3.7	Construction industry measurement standards, guidance and practice, including measurement rules	SDK1.3 SDK1.4	SDS1.3 SDS1.10
	K3.8	Good survey practice, e.g. whole to the part, local vs national and error propagation	SDK1.3 SDK1.4	SDS1.3
<b>Performance outcome</b>	<b>Ref#</b>	<b>Skill content</b>	<b>New Pearson ref#</b>	
	S1.1	Explore requirements of the task, using open questioning and listening.	SDS1.1	
	S1.2	Gather information from appropriate sources specific to the scope of works, including Geographical Information	SDS1.2	
	S1.3	Determine the level of accuracy required.	SDS1.3	
	S1.4	Capture data, using appropriate measurement methods.	SDS1.4	
	S1.5	Process data, using appropriate techniques	SDS1.5	
	S1.6	Extract and manage data, using appropriate techniques.	SDS1.6	
	S1.7	Quality assure the surveying measurements.	SDS1.7	
	S1.8	Communicate health and safety risks associated with the task and environment, using appropriate methods	SDS1.8	

	S1.9	Assess health and safety risks associated with the task and environment.	SDS1.9	
	S1.10	Select and use tools and equipment with accuracy and efficiency.	SDS1.10	
	S1.11	Operate equipment and perform tasks safely.	SDS1.11	
	S1.12	Manage waste, including the quantification, classification and disposal of waste.	SDS1.12	
<b>Performance outcome</b>	<b>Ref#</b>	<b>Knowledge content</b>	<b>New Pearson ref#</b>	<b>Assessed under skill</b>
<b>2: Analyse the built environment</b>	<b>K4</b>	<b>Project management</b>		
	K4.1	Project programmes	SDK2.1 SDK2.3 SDK2.4	SDS2.1 SDS2.2 SDS2.4
	K4.2	Digital workflows	SDK2.2 SDK2.3 SDK2.4	SDS2.4 SDS2.3
	<b>K5</b>	<b>Sustainability</b>		
	K5.2	How and why sustainability seeks to balance economic, environmental and social objectives	SDK2.1 SDK2.2 SDK2.3	SDS2.2 SDS2.3
	K5.3	Legal obligations relating to pollution and waste.	SDK2.2	SDS2.3
<b>Performance outcome</b>	<b>Ref#</b>	<b>Skill content</b>	<b>New Pearson ref#</b>	
	S2.1	Sequence and prioritise tasks.	SDS2.1	
	S2.2	Analyse information available to determine requirements of the task.	SDS2.2	
	S2.3	Interpret information and data, including from visual and other sources	SDS2.3	
	S2.4	Convey data	SDS2.4	

Performance outcome	Ref#	Knowledge content	New Pearson ref#	Assessed under skill
<b>3: Design the built environment</b>	<b>K2</b>	<b>Digital technology</b>		
	K2.1	How the Internet of Things contributes to the measurement of the built environment	SDK3.6	SDS3.5 SDS3.6
	K2.2	Geospatial equipment, their applications, suitability and use	SDK3.1 SDK3.2 SDK3.5	SDS3.2 SDS3.4 SDS3.7 SDS3.10
	K2.3	Digital engineering techniques and appropriate software	SDK3.1 SDK3.2 SDK3.5	SDS3.10
	K2.5	Digital design tools, e.g. computer-aided design (CAD)	SDK3.6	SDS3.5 SDS3.6
	K2.6	Digital specification tools, e.g. the National Building Specification (NBS), BS 1192	SDK3.6	SDS3.5 SDS3.6
	K2.7	Digital data, e.g. spreadsheets and schedules	SDK3.6	SDS3.5 SDS3.6
	K2.8	Digital presentation, image handling and desktop publishing, e.g. brochures and reports	SDK3.6	SDS3.5 SDS3.6
	<b>K5</b>	<b>Sustainability</b>		
	K5.1	Digital workflows	SDK3.1	SDS3.1
	K5.2	How and why sustainability seeks to balance economic, environmental and social objectives	SDK3.1	SDS3.1
	K5.3	Legal obligations relating to pollution and waste.	SDK3.1	SDS3.1
	K5.4	Environmental performance measures that must be met and how they are measured	SDK3.4	SDS3.3
	K5.5	Principles of heritage and conservation	SDK3.1	SDS3.1
	<b>K6</b>	<b>Design</b>		
	K6.1	How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes	SDK3.5	SDS3.10



K6.2	The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent	SDK3.5	SDS3.10
K6.3	The implications of statutory obligations to designs, e.g. utility diversion	SDK3.5	SDS3.10
K6.4	The use and importance of specifications, e.g. as applicable to design guides and legislation	SDK3.5	SDS3.10
K6.5	The relevance of measurement in the design process, e.g. area (net and gross) volume, height and length	SDK3.5	SDS3.10
K6.6	Technical drawing techniques	SDK3.5 SDK3.6	SDS3.5 SDS3.6 SDS3.10
K6.7	Inclusive design, including equality and diversity by impact	SDK3.5	SDS3.10
<b>K7</b>	<b>Health and safety</b>		
K7.1	The CDM Regulations 2015 and the duties of the designer	SDK3.7	SDS3.8
K7.2	The identification and design of hazards, and risks and methods of assessment, e.g. Design Risk Assessments (CDM 2015)	SDK3.7	SDS3.8
K7.3	Fire and emergency safety, e.g. the Hackitt Review	SDK3.7	SDS3.8
<b>K8</b>	<b>Relationship management</b>		
K8.1	Negotiation, mediation and conflict management techniques, and their suitability for different situations	SDK8.3	SDS3.9
K8.2	Consultation requirements, e.g. the expertise and input of third-party knowledge	SDK8.3	SDS3.9
K8.3	Processes of collaborative design, e.g. coordination of team input and clash management	SDK8.3	SDS3.9

Performance outcome	Ref#	Skill content	New Pearson ref#	
	S3.1	Identify information and data required to complete the task	SDS3.1	
	S3.2	Quality assure information and data, including third-party expertise	SDS3.2	
	S3.3	Conduct precedent research, including best practice, benchmarks and design guides.	SDS3.3	
	S3.4	Use suitable data, quality assured in line with best practice	SDS3.4	
	S3.5	Model design, using digital software and other tools and techniques	SDS3.5	
	S3.6	Present appropriate design information and data, using different methods and formats.	SDS3.6	
	S3.7	Manage data in a collaborative environment	SDS3.7	
	S3.8	Communicate design and construction risks, using appropriate methods	SDS3.8	
	S3.9	Manage relationships.	SDS3.9	
	S3.10	Provide creative solutions to challenges arising from requirements.	SDS3.10	
	S3.11	Adapt design proposals in response to design constraints and stakeholder feedback, in terms of time, cost and material factors.	SDS3.11	

Performance outcome	Ref#	Knowledge content	New Pearson ref#	Assessed under skill
<b>4: Verify delivery of the built environment</b>	<b>K3</b>	<b>Measurement</b>		
	K3.9	Types of measurement for the combined data	SDK4.1	SDS4.1
	K3.10	Techniques for value engineering	SDK4.5	SDS4.5
	K3.11	Rules of measurement and contractual implications	SDK4.6	SDS4.6
	<b>K5</b>	<b>Sustainability</b>		
	K5.4	Environmental performance measures that must be met and how they are measured	SDK4.1	SDS4.1
	K5.5	Principles of heritage and conservation	SDK4.1	SDS4.1
	<b>K9</b>	<b>Valuations</b>		
	K9.1	Industry valuation standards, guidance and practice and how these are used to verify delivery of the built environment	SDK4.5	SDS4.5 SDS4.6
	K9.2	Valuation benchmarking and how this is used to verify delivery of the built environment	SDK4.5	SDS4.5 SDS4.6

Performance outcome	Ref#	Skill content	New Pearson ref#	
	S4.1	Verify suitability of information and data from appropriate sources specific to the scope of works.	SDS4.1	
	S4.2	Interpret information and data, including from visual and other sources.	SDS4.2	
	S4.3	Present information, using oral, visual and written communication	SDS4.3	
	S4.4	Use software with accuracy to verify specific items, utilising appropriate tools	SDS4.4	
	S4.5	Complete costings analysis through the use of market rates and spreadsheet software, including best value and whole life costing	SDS4.5	
	S4.6	Apply appropriate mathematical techniques in a construction context	SDS4.6	

## Occupational Specialism: Civil Engineering

Performance outcome	Ref#	Knowledge content	New Pearson ref#	Assessed under skill
<b>1: Analyse civil engineering solutions</b>	<b>K1</b>	<b>Health and safety</b>		
	K1.1	Task-specific risk management, including hazards, risk assessment, controls	CEK1.1 CEK1.5	CES1.2 CES1.3 CES1.5 CES1.7 CES1.12
	<b>K2</b>	<b>Sustainability</b>		
	K2.1	How sustainability is embedded into solutions	CEK1.7	CES1.12
	K2.2	How and why sustainability seeks to balance economic, environmental and social objectives, e.g. whole life, including decommissioning	CEK1.7 CEK1.9	CES1.10
	<b>K3</b>	<b>Project management</b>		
	K3.1	Project and construction risk management, e.g. consideration of project management solutions	CEK1.1 CEK1.6	CES1.2 CES1.4 CES1.5 CES1.7
	<b>K4</b>	<b>Design</b>		
	K4.1	Inclusive design, including equality and diversity by impact assessment	CEK1.1 CEK1.7	CES1.2 CES1.5 CES1.7 CES1.12
	K4.2	Methods used to test structures, e.g. stress, aerodynamics	CEK1.7	CES1.12
	<b>K5</b>	<b>Material properties</b>		
	K5.1	Concrete, glass, timber, steel, including mass and density, strength (tensile, compressive, shear), bending stiffness, fatigue and creep, degradation and resistance to degradation (including corrosion and chemical degradation), embedded energy, recycling potential and material failure	CEK1.1 CEK1.7 CEK1.11	CES1.2 CES1.5 CES1.7 CES1.12 CES1.13

	<b>K6</b>	<b>Structural elements, loading and potential failure</b>		
	K6.1	Beams, frames, walls; effect of different loading conditions and failure of, e.g. beams, walls, frames, struts and ties	CEK1.11	CES1.13
	<b>K7</b>	<b>Maths for structural analysis</b>		
	K7.1	Relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams	CEK1.11	CES1.13
	<b>K8</b>	<b>Structural mechanics</b>		
	K8.1	How structural elements (e.g. beams, columns, frameworks) behave under load	CEK1.11	CES1.13
	K8.2	Structural mechanics problems, e.g. reactive forces, maximum load	CEK1.11	CES1.13
	K8.3	How structural elements behave under load	CEK1.11	CES1.13
	K8.4	Structural mechanics problems	CEK1.11	CES1.13
	<b>K9</b>	<b>Mathematical techniques</b>		
	K9.1	Algebra, including indices, logarithms, linear equations	CEK1.11	CES1.13
	K9.2	Trigonometric and standard formulae, including circular and triangular measures	CEK1.11	CES1.13
	K9.3	Elementary calculations and techniques, including integration and differentiation	CEK1.11	CES1.13
	K9.4	Statistical methods, including averages, tendency and dispersion	CEK1.1 CEK1.11	CES1.2 CES1.5 CES1.7 CES1.13
	<b>K10</b>	<b>Geology/substructure beyond the core</b>		
	K10.1	Bore holes, trial pits; groundwater – water table, contamination; ground load bearing capacity	CEK1.1	CES1.2 CES1.5 CES1.7

	<b>K11</b>	<b>Setting out</b>		
	K11.1	Techniques for setting-out points and developing the physical positions of elements of a building from the plan	CEK1.2	CES11.1
	<b>K12</b>	<b>Earthworks</b>		
	K12.1	Excavation, cuttings, embankments, earth moving equipment and concreting equipment	CEK1.5	CES1.3
	<b>K13</b>	<b>Measurement</b>		
	K13.4	Techniques for value engineering	CEK1.4	CES1.1
	<b>K14</b>	<b>Digital Technology</b>		
	K14.1	Digital design tools	CEK1.12	CES1.14 CES1.16 CES1.17
	K14.2	Digital specification tools	CEK1.12	CES1.14 CES1.16 CES1.17
	K14.3	Digital data	CEK1.1 CEK1.12	CES1.2 CES1.5 CES1.7 CES1.14 CES1.16 CES1.17
	K14.4	Digital presentation, image handling and desktop publishing	CEK1.1 CEK1.12	CES1.2 CES1.5 CES1.7

Performance outcome	Ref#	Skill content	New Pearson ref#	
	S1.1	Sequence and prioritise individual tasks.	CES1.1	
	S1.2	Identify information and data requirements	CES1.2	
	S1.3	Assess health and safety risks associated with the task.	CES1.3	
	S1.4	Adapt actions to the level of risk.	CES1.4	
	S1.5	Select data collection and analysis methods.	CES1.5	
	S1.6	Inspect the suitability of tools and equipment.	CES1.6	
	S1.7	Quality assure the surveying measurements.	CES1.7	
	S1.8	Use tools and equipment with accuracy	CES1.8	
	S1.9	Operate safely and apply good housekeeping	CES1.9	
	S1.10	Extract relevant information from appropriate sources.	CES1.10	
	S1.11	Quality assure the processes used to collect information and data against protocols and standards	CES1.11	
	S1.12	Analyse environments against client brief to identify potential issues and problems	CES1.12	
	S1.13	Carry out calculations related to the scope of work	CES1.13	
	S1.14	Use appropriate techniques to check accuracy of analysis.	CES1.14	
	S1.15	Produce sketches based on information and data	CES1.15	
	S1.16	Model analysed information and data, including geotechnical, structural and materials, as appropriate for audience, using digital software	CES1.16	
	S1.17	Collate information and data into digital engineering software.	CES1.17	



Performance outcome	Ref#	Knowledge content	New Pearson ref#	Assessed under skill
<b>2: Design civil engineering solutions</b>	<b>K4</b>	<b>Design</b>		
	K4.3	How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes	CEK2.1	CES2.1
	K4.4	The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent	CEK2.6	CES2.8
	K4.5	The implications of statutory obligations to designs	CEK2.8	CES2.7
	K4.6	The use and importance of specifications	CEK2.8	CES2.7
	K4.7	The relevance of measurement in the design process	CEK2.8	CES2.7 CES1.12
	<b>K5</b>	<b>Material properties</b>		
	K5.2	Concrete, glass, timber, steel, including mass and density, strength (tensile, compressive, shear), bending stiffness, fatigue and creep, degradation and resistance to degradation (including corrosion and chemical degradation), embedded energy, recycling potential and material failure	CEK2.9	CES2.9
	<b>K6</b>	<b>Structural elements, loading and potential failure</b>		
	K6.2	Beams, frames, walls; effect of different loading conditions and failure of, e.g. beams, walls, frames, struts and ties	CEK2.1	CES2.1
	<b>K7</b>	<b>Maths for structural analysis</b>		
	K7.2	Relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams	CEK2.12	CES2.6

<b>K8</b>	<b>Structural mechanics</b>		
K8.3	How structural elements behave under load	CEK2.9	CES2.9
K8.4	Structural mechanics problems	CEK2.9	CES2.9
<b>K9</b>	<b>Mathematical techniques</b>		
K9.5	Algebra, including indices, logarithms, linear equations	CEK2.12	CES2.6
K9.6	Trigonometric and standard formulae, including circular and triangular measures	CEK2.12	CES2.6
K9.7	Elementary calculations and techniques, including integration and differentiation	CEK2.12	CES2.6
K9.8	Statistical methods, including averages, tendency and dispersion	CEK2.12	CES2.6
<b>K10</b>	<b>Geology/ substructure beyond the core</b>		
K10.1	Bore holes, trial pits; groundwater – water table, contamination; ground load bearing capacity	CEK2.1	CES2.1
<b>K11</b>	<b>Setting out</b>		
K11.2	Techniques for setting-out points and developing the physical positions of elements of a building from the plan	CEK1.2 CEK2.4 CEK2.12	CES2.6 CES2.12
<b>K13</b>	<b>Earthworks</b>		
K13.1	Measurement standards, guidance and practice	CEK2.4	CES1.12
K13.2	Types of surveying equipment	CEK2.4	CES1.12
K13.4	Techniques for value engineering	CEK1.4 CEK2.4	CES1.12
<b>K14</b>	<b>Digital technology</b>		
K14.1	Digital design tools	CEK2.6	CES2.8
K14.2	Digital specification tools	CEK2.6	CES2.8
K14.3	Digital data	CEK1.1 CEK2.6	CES2.8
K14.4	Digital presentation, image handling and desktop publishing	CEK1.1 CEK2.6 CEK2.12	CES2.6 CES2.8

	K15.1	Industry valuation standards, guidance and practice, and how these are used to verify delivery of the built environment	CEK2.4 CEK2.12	CES1.12
	K15.2	Valuation benchmarking and how this is used to verify delivery of the built environment	CEK2.4 CEK2.12	CES1.12
<b>Performance outcome</b>	<b>Ref#</b>	<b>Skill content</b>	<b>New Pearson ref#</b>	
	S2.1	Extract relevant information and data.	CES2.1	
	S2.2	Quality assure provided data	CES2.2	
	S2.3	Conduct precedent research into potential solutions to a problem, including best practice, benchmarks and design guides.	CES2.3	
	S2.4	Think creatively, adapting to challenges arising from requirements	CES2.4	
	S2.5	Assess commercial risk related to potential solutions	CES2.5	
	S2.6	Apply mathematical principles to the scope of work	CES2.6	
	S2.7	Resolve technical issues in the design	CES2.7	
	S2.8	Select methods to present information	CES2.8	
	S2.9	Determine performance of materials	CES2.9	
	S2.10	Use appropriate techniques to confirm validity of calculations	CES2.10	
	S2.11	Model information, using appropriate digital software and other tools.	CES2.11	
	S2.12	Use appropriate techniques to check accuracy of measurements, including scale and proportion, e.g. Ground Validation Points (GVP), known measurements	CES2.12	
	S2.13	Draw on a range of media to communicate a design proposal.	CES2.13	

Performance outcome	Ref#	Knowledge content	New Pearson ref#	Assessed under skill
<b>3: Verify delivery of civil engineering solutions</b>	<b>K1</b>	<b>Health and safety</b>		
	K1.1	Task-specific risk management, including hazards, risk assessment, controls	CEK3.6	
	<b>K5</b>	<b>Material properties</b>		
	K5.3	Concrete, glass, timber, steel, including mass and density, strength (tensile, compressive, shear), bending stiffness, fatigue and creep, degradation and resistance to degradation (including corrosion and chemical degradation), embedded energy, recycling potential and material failure	CEK3.3	CES3.3
	<b>K8</b>	<b>Structural mechanics</b>		
	K8.2	Structural mechanics problems, e.g. reactive forces, maximum load	CEK3.6	CES3.6 CES3.7
	K8.5	How structural elements behave under load	CEK3.3 CEK3.6	CES3.3 CES3.6 CES3.7
	K8.6	Solve structural mechanics problems	CEK3.6	CES3.6 CES3.7
	<b>K9</b>	<b>Mathematical techniques</b>		
	K9.9	Algebra, including indices, logarithms, linear equations	CEK3.6	CES3.6 CES3.7
	K9.10	Trigonometric and standard formulae, including circular and triangular measures	CEK3.6	CES3.6 CES3.7
	K9.11	Elementary calculus and techniques, including integration and differentiation	CEK3.6	CES3.6 CES3.7
	K9.12	Statistical methods, including averages, tendency and dispersion	CEK3.6	CES3.6 CES3.7
	<b>K10</b>	<b>Geology/ substructure beyond the core</b>		
K10.3	Bore holes, trial pits; groundwater – water table, contamination; ground load bearing capacity	CEK3.2	CES3.2	

	<b>K11</b>	<b>Setting out</b>		
	K11.3	Techniques for setting-out points and developing the physical positions of elements of a building from the plan	ECK3.6	CES3.6 CES3.7
	<b>K12</b>	<b>Earthworks</b>		
	K12.3	Excavation, cuttings, embankments, earth moving equipment and concreting equipment	CEK3.2	CES3.2
	<b>K13</b>	<b>Measurements</b>		
	K13.4	Techniques for value engineering	CEK3.3	CES3.3
	K13.5	Rules of measurement and contractual implications	CEK3.3	CES3.3
	<b>K14</b>	<b>Digital Technology</b>		
	K14.1	Digital design tools	CEK3.4	CES3.4
	K14.2	Digital specification tools	CEK3.4	CES3.4
	K14.3	Digital data	CEK3.4	CES3.4
	K14.4	Digital presentation, image handling and desktop publishing	CEK3.4 CEK3.5	CES3.4 CES3.5
	<b>K15</b>	<b>Valuations</b>		
	K15.5	Industry valuation standards, guidance and practice, and how these are used to verify delivery of the built environment	CEK3.3 CEK3.4	CES3.3 CES3.4
	K15.2	Valuation benchmarking and how this is used to verify delivery of the built environment	CEK3.3 CEK3.4	CES3.3 CES3.4

Performance outcome	Ref#	Skill content	New Pearson ref#	
	S3.1	Extract relevant information from provided sources.	CES3.1	
	S3.2	Process geotechnical and structural behaviour and human factors information, and data related to the performance of a proposed solution	CES3.2	
	S3.3	Interpret information and data, including from visual and other sources.	CES3.3	
	S3.4	Complete technical reports	CES3.4	
	S3.5	Use digital engineering software with accuracy	CES3.5	
	S3.6	Complete costings analysis.	CES3.6	
	S3.7	Apply appropriate mathematical techniques to solve structural mechanics problems, including algebra, statistics, trigonometry, calculus	CES3.7	

## Occupational Specialism: Building Services Design

Performance outcome	Ref#	Knowledge content	New Pearson ref#
<b>1: Analyse building service solutions</b>	<b>K1</b>	<b>Health and safety</b>	
	K1.1	Key requirements, roles and responsibilities associated with health and safety legislation	BDSK1.1
	K1.2	Legal health and safety obligations of existing installations	BDSK1.1
	<b>K2</b>	<b>Sustainability</b>	
	K2.1	Key requirements, roles and responsibilities associated with environmental protection legislation	BDSK1.2
	K2.2	Financial incentives	BDSK1.2
	K2.3	Environmental performance measures associated with building services systems	BDSK1.2
	K2.4	Energy efficiency of building services systems	BSDK2.2
	K2.5	Types of fuel, including storage	BSDK1.5
	<b>K3</b>	<b>Scientific concepts and principles and their application to building services systems</b>	
	K3.1	International System of Units (SI), including base units for length, mass, time, electrical current, temperature, amount of substance, luminous intensity	BDSK1.3
	K3.2	Derived SI units, including those associated with area, volume, weight, energy and force	BDSK1.3
	K3.3	Gas laws, including Charles's law, Boyle's law	BDSK1.3
	K3.4	Electrical systems and properties, including current, magnetic flux, density, frequency, resistance, voltage, Ohm's law, power, acceleration	BDSK1.3
	K3.5	Mechanical properties, systems and units, including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects	BDSK1.3
	K3.6	Strength, including tensile, compressive, shear	BDSK1.3
	K3.7	Thermodynamics, including laws, material science, phase transition	BDSK1.3

	K3.8	Properties of materials, including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure	BDSK1.3
	K3.9	Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft	BDSK1.3
	<b>K4</b>	<b>Building structures</b>	
	K4.1	Purposes, importance and types of flues and chimneys	BSDK1.4
	<b>K5</b>	<b>Principles of building services engineering systems</b>	
	K5.1	Types of system, their purposes, similarities and differences in operation Mechanical components, their characteristics, function within the system and implications for the system of component failure Electrotechnical components, their characteristics, function within the system and implications for the system of component failure	BDSK1.5
	K5.2	Types of control system, their purposes, components, similarities and differences	BDSK1.5
	K5.3	Monitoring systems (digital, analogue) and how they collect and transmit data	BDSK1.5
	<b>K6</b>	<b>Sources of information, their content and purpose</b>	
	6.1	Visuals	BDSK1.6
<b>Performance outcome</b>	<b>Ref#</b>	<b>Skill content</b>	<b>New Pearson ref#</b>
	S1.1	Analyse information to determine requirements of the task.	BSDS1.1
	S1.2	Gather required information.	BSDS1.2
	S1.3	Sequence and prioritise individual tasks.	BSDS1.3
	S1.4	Interpret information and data, including from visual and other sources.	BSDS1.4
	S1.5	Process data, using appropriate techniques.	BSDS1.5
	S1.6	Analyse and convey data, using appropriate techniques.	BSDS1.6
	S1.7	Calculate data required for design.	BSDS1.7



Performance outcome	Ref#	Knowledge content	New Pearson ref#
<b>2: Design building services</b>	<b>K1</b>	<b>Health and safety</b>	
	K1.3	CDM responsibilities	BSDK2.1 BSDK2.2
	K1.4	Legal and health and safety implications of proposed designs for existing designs	BSDK2.3 BSDK2.4
	<b>K2</b>	<b>Sustainability</b>	
	K2.4	Energy efficiency of building services systems	BSBK2.2
	K2.5	Types of fuel, including storage	BSBK2.1
	<b>K3</b>	<b>Scientific concepts and principles and their application to building services systems</b>	
	K3.1	International System of Units (SI), including base units for length, mass, time, electrical current, temperature, amount of substance, luminous intensity	BSBK1.3
	K3.2	Derived SI units, including those associated with area, volume, weight, energy and force	BSBK1.3
	K3.3	Gas laws, including Charles's law, Boyle's law	BSBK1.3
	K3.4	Electrical systems and properties, including current, magnetic flux, density, frequency, resistance, voltage, Ohm's law, power, acceleration	BSBK1.3
	K3.5	Mechanical properties, systems and units, including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects	BSBK1.3
	K3.6	Strength, including tensile, compressive, shear	BSBK1.3
	K3.7	Thermodynamics, including laws, material science, phase transition	BSBK1.3
	K3.8	Properties of materials, including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure	BSBK1.3
K3.9	Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft	BSBK1.3	

	<b>K4</b>	<b>Building structures*</b>	
	K4.1	Purposes, importance and types of flues and chimneys	BSBK1.4
	<b>K5</b>	<b>Principles of building services engineering systems*</b>	
	K5.1	Types of system, their purposes, similarities and differences in operation Mechanical components, their characteristics, function within the system and implications for the system of component failure Electrotechnical components, their characteristics, function within the system and implications for the system of component failure	BSBK1.5
	K5.2	Types of control system, their purposes, components, similarities and differences	BSBK1.5
	K5.3	Monitoring systems (digital, analogue) and how they collect and transmit data	BSBK1.5
	<b>K6</b>	<b>Sources of information, their content and purpose*</b>	
	K6.1	Visuals	BSBK1.6
	<b>K7</b>	<b>Construction and the built environment industry</b>	
	<b>K7.1</b>	<b>Planning permission and building regulations relating to all notifiable works</b>	<b>BSBK2.1</b>
	<b>K8</b>	<b>Building technology</b>	
	K8.1	Properties of materials, including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure	BSBK1.3
	K8.2	Understanding mechanical, electrical and plumbing components	BSDK2.4
	<b>K9</b>	<b>Digital technology</b>	
	K9.1	Specialist software and digital tools	BDSK2.5
	K9.2	Digital design tools	BDSK2.6
	K9.3	Digital specification tools	BDSK2.7
	K9.4	Digital data	BDSK2.8
	K9.5	Digital presentations, image handling and desktop publishing	BDSK2.9

	<b>K10</b>	<b>Design</b>	
	K10.1	How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes	BSDK2.2
	K10.2	The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent	BSDK2.2
	K10.3	The implications of statutory obligations to designs	BSDK2.2
	K10.4	The use and importance of specifications	BSDK2.2
	K10.5	The relevance of measurement in the design process	BSDK2.2
<b>Performance Outcome</b>	<b>Ref#</b>	<b>Skill content</b>	<b>New Pearson ref#</b>
	S2.1	Explore requirements of the task, using open questioning and listening.	BSDS2.1
	S2.2	Use appropriate data and information	BSDS2.2
	S2.3	Conduct precedent research, including best practice, benchmarks and design guides	BSDS2.3
	S2.4	Quality assure provided data.	BSDS2.4
	S2.5	Plan logistics, including life cycle, costing, maintenance and installation	BSDS2.5
	S2.6	Apply appropriate mathematical techniques in a construction context	BSDS2.6
	S2.7	Model design, using digital software and other tools	BSDS2.7
	S2.8	Present appropriate design information and data, using different methods and formats.	BSDS2.8
	S2.9	Enter data into digital engineering software.	BSDS2.9
	S2.10	Provide creative solutions to challenges arising from requirements	BSDS2.10
	S2.11	Adapt design proposals in response to design constraints and stakeholder feedback in terms of time, cost and material factors	BSDS2.11

Performance Outcome	Ref#	Knowledge content	New Pearson ref#
<b>3: Verify delivery of building services</b>	<b>K2</b>	<b>Sustainability</b>	
	K2.4	Energy efficiency of building services systems	BSBK2.2
	K2.5	Types of fuel, including storage	BSBK2.1
	<b>K3</b>	<b>Scientific concepts and principles and their application to building services systems*</b>	
	K3.1	Collate information and data	BSDS3.1
	K3.2	Verify suitability of information and data from appropriate sources specific to the scope of works	BSDS3.2
	K3.3	Interpret information and data, including from visual and other sources	BSDS3.3
	K3.4	Use software with accuracy to verify specific items, utilising appropriate tools	BSDS3.4
	K3.5	Complete costings analysis.	BSDS3.5
	K3.6	Present information, using oral and written communication	BSDS3.6
	<b>K4</b>	<b>Building structures</b>	
	K4.1	Purposes, importance and types of flues and chimneys	BSDK1.4
	<b>K5</b>	<b>Principles of building services engineering systems</b>	
	K5.1	Types of system, their purposes, similarities and differences in operation	BSDK1.5
	K5.1	Mechanical components, their characteristics, function within the system and implications for the system of component failure	BSDK1.5
	K5.1	Electrotechnical components, their characteristics, function within the system and implications for the system of component failure	BSDK1.5
	K5.2	Types of control system, their purposes, components, similarities and differences	BSDK1.5
	K5.3	Monitoring systems (digital, analogue) and how they collect and transmit data	BSDK1.5
	<b>K6</b>	<b>Sources of information, their content and purpose</b>	
	K6.1	Visuals	BSDK1.6

	<b>K8</b>	<b>Building technology</b>	
	K8.3	Suitability and operation of performance measurement equipment	BSDK3.4
	K8.4	Surveying techniques	BSDK3.4
	<b>K11</b>	<b>Valuations</b>	
	K11.1	Industry valuation standards, guidance and practice, and how these are used to verify delivery of the built environment	BSDK3.1
	K11.2	Valuation benchmarking and how this is used to verify delivery of the built environment	BSDK3.2
	<b>K12</b>	<b>Measurements</b>	
	K12.1	Types of measurement for the combined data	BSDK3.3
	K12.2	Techniques for value engineering	BSDK3.4
	K12.3	Rules of measurement and contractual implications	BSDK3.5
<b>Performance Outcome</b>	<b>Ref#</b>	<b>Skill content</b>	<b>New Pearson ref#</b>
	S3.1	Collate information and data.	BSDS3.1
	S3.2	Verify suitability of information and data from appropriate sources specific to the scope of works.	BSDS3.2
	S3.3	Interpret information and data, including from visual and other sources	BSDS3.3
	S3.4	Use software with accuracy to verify specific items, utilising appropriate tools	BSDS3.4
	S3.5	Complete costings analysis through, for example, spreadsheet software	BSDS3.5
	S3.6	Present information, using oral and written communication	BSDS3.6



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