

T LEVEL

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

Specification

First teaching from September 2022
Version 1.2 April 2022



Pearson

T Level Technical Qualification in Design, Surveying and Planning for Construction

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About Pearson

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This specification is version 1.2. We will inform providers of any changes to this version through bulletins and provider updates. The latest version can be found on our website.

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Welcome to career-ready education

T Levels are new two-year, Level 3 study programmes that will follow the study of GCSEs and Technical Awards at Key Stage 4 and offer an attractive alternative to A Levels and Apprenticeships. T Levels will combine classroom theory, practical learning and a minimum 315 hours of industry placement with an employer to make sure students have real experience of the workplace.

The Technical Qualification (TQ) is the main classroom-based element of the T Level and will see students learning from a qualification that has been shaped by industry experts. During the two-year programme, students will learn the core knowledge that underpins each industry and they will also develop occupationally specific skills that will allow them to enter skilled employment within a specific occupation.

The T Level programmes have been developed in collaboration with employers and businesses so the content will meet the needs of industry and prepare students for work. They provide the knowledge and experience needed to open the door to highly skilled employment, an Apprenticeship or higher-level study, including university.

Technical Qualification and collaboration

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, based on the same standards as those used for Apprenticeships. Employers involved in designing the Outline Content include Skanska and Morgan Sindall.

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

- Elaboration of the Outline Content to provide a specification that gives Providers an accurate interpretation of what is required to be taught and assessed
- Enabling students to achieve threshold competence in relation to each Occupational Specialist Component
- The integration of English, Maths and Digital skills.

Students who complete a *T Level Technical Qualification in Design, Surveying and Planning for Construction* will be able to choose between moving into a skilled occupation or further study; for example, a higher or degree level Apprenticeship, or higher-level technical study, including higher education. Therefore, it was essential we developed the qualification in close collaboration with experts from professional bodies, businesses, universities, and with the Providers who will be delivering the qualification.

Our engagement with experts during the development of the qualification ensures the content will meet your needs and give students quality preparation to help them progress. We are 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 higher-education providers who have worked with us 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.

This qualification has been developed under the advice of the professional bodies listed below, on behalf of the Engineering Council, in order to confirm that the qualification contributes to the requirements for professional registration; for example as an Engineering Technician (EngTech) or associate member of their professional organisation.

This qualification has been developed under the advice of the professional bodies who were part of our validation panel, including:

- Chartered Institution of Building Services Engineers
- Institution of Civil Engineers
- Royal Institution of Chartered Surveyors.

In addition, the Civil Engineering pathway of the qualification has been formally approved as meeting the Educational Base for the EngTech professional standard by the Institution of Civil Engineers.

Summary of changes (Version 1.2 for students starting T Levels from Sept 2022)	
Addition of threshold competence definition.	Page 6
Added AC and DC voltage to 2.4.1	Page 17
Removed convection from 2.5.1	Page 18
2.8.5 changed to provide guidance on calculations	Page 19
Planning software added to 13.3.2	Page 52
Additional information on awarding the core component.	Page 240

Summary of changes to Version 1.1	
Change to title to show version publication date, for clarity.	Front cover
Insertion of specification version.	Title page
Removal of Reference to third party material statement, for clarity.	Imprint page
Insertion of 'In addition, the Civil Engineering pathway of the qualification has been formally approved as meeting the Educational Base for the EngTech professional standard by the Institution of Civil Engineers', for information.	Welcome section
Removal of statement 'students will need to achieve a minimum standard of English and Maths, either GCSE grade 4 or above, or level 2 Functional skills', this is no longer a requirement of the T level.	Throughout
Addition of Unclassified grade, for clarity.	Throughout
Addition of Transferring between T levels statement, for information.	Page 7
Minor formatting changes to the main body and footer of the specification.	Throughout

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1. Qualification summary and key information

T Level Technical Qualification in Design, Surveying and Planning for Construction							
Total Guided Learning Hours (GLH)		1200 GLH					
Total Qualification Time (TQT)		1470 TQT					
First registration:	September 2020	Recommended age range:				16–19	
Core Component:	600 GLH 810 TQT	Grade:	A*–E and Unclassified				
Assessment component	Assessment method	Duration	Marks	Weighting	Timetable	Availability	Marking approach
Core Paper 1: Science and Building Technology	Written examination paper	2.5 hours	100	33.33%	Set date and time	May/June November	Externally marked
Core Paper 2: Construction Industry and Sustainability	Written examination paper	2.5 hours	100	33.33%	Set date and time	May/June November	Externally marked
Employer Set Project	Externally set project	15.5 hours	100	33.33%	Window	May/June November	Externally marked
Occupational Specialist Component:	600 GLH 660 TQT	Grade:	P, M, D and Unclassified				
Surveying and design for construction and the built environment	Externally set project	30 hours	180	100%	Task-specific: window/set date and time	May/June	Externally marked
Civil engineering	Externally set project	25 hours	180	100%	Task-specific: window/set date and time	May/June	Externally marked
Building services design	Externally set project	20 hours, 40 mins	180	100%	Task-specific: window/set date and time	May/June	Externally marked
Hazardous materials analysis and surveying	Externally set project	15 hours, 30 mins	180	100%	Task-specific: window/set date and time	May/June	Externally marked

If a student completes the assessments but is not successful in reaching the minimum threshold for the Core and Occupational specialism component, they will be issued with a U grade.

T Level Technical Qualification in Design, Surveying and Planning for Construction			
Qualification Number (QN)	603/5830/0		
First Registration Date	September 2020		
Approved Age Range	16–19		
Total Guided Learning Hours (GLH)	1200 GLH*		
Total Qualification Time (TQT)	1470 TQT*		
Assessment	All assessments are externally set and marked by Pearson		
Grading Overview	Core	Occupational Specialism	Overall
	All grades for this component will be on a scale of A* – E and Unclassified	All grades for this component will be on a scale of Pass, Merit, Distinction and Unclassified	The overall grade will be on a scale of Unclassified, Pass, Merit, Distinction, Distinction * #

* See Section 2 below for further information about GLH and TQT.

Pearson will not award the overall grade for the Technical Qualification. The overall grade will be awarded by the Institute for Apprenticeships and Technical Education (the Institute). See *Section 10 Technical Qualification Grading, T Level grading and results reporting* for further information. If a student completes the assessments but is not successful in reaching the minimum threshold for the core and/or occupational specialism component, they will be issued with a U grade.

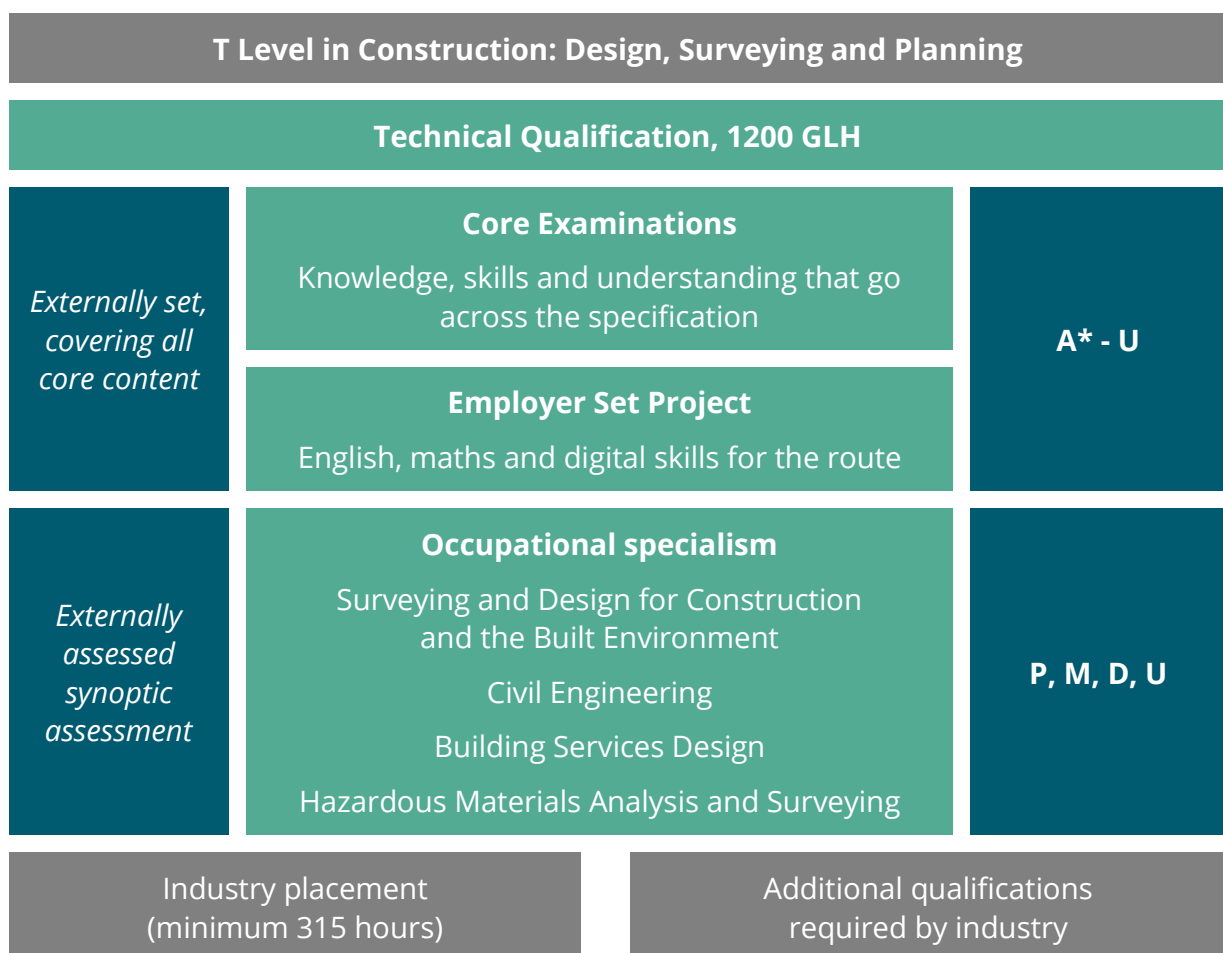
2. Introduction to the T Level Technical Qualification in Design, Surveying and Planning for Construction

This specification contains all the information you need to deliver the *T Level Technical Qualification in Design, Surveying and Planning for Construction*.

This qualification forms the substantive part of the *T Level Technical Qualification in Design, Surveying and Planning for Construction*, which includes other elements that are required to be successfully completed in order for students to be awarded the T Level from the Institute for Apprenticeships and Technical Education (the Institute).

The *T Level in Construction: Design, Surveying and Planning* will include:

- a 315-hour industry placement that is related to the occupational specialism selected by the student.



Qualification 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. It has 600 GLH and is assessed by two externally set Core Examinations and an Employer Set Project.

The content and details for each of these assessments is provided in *Section 4 Core Component*.

2. Occupational Specialist Components

There are four Occupational Specialist Components in this qualification, each of which has 600 GLH:

1. Surveying and design for construction and the built environment
2. Civil engineering
3. Building services design
4. Hazardous materials analysis and surveying.

Students undertaking the *T Level Technical Qualification in Design, Surveying and Planning for Construction* will be able to choose **one** of the four Occupational Specialisms to complete as part of their T Level Technical Qualification.

These components cover the occupational specialist knowledge and skills required to demonstrate threshold competence for the specialism. Each Occupational Specialism will be assessed by a skills-related project that synoptically assesses the performance outcome skills and associated underpinning knowledge.

The content and details of the assessment for Occupational Specialist Components are provided from *Section 5* onwards.

Total Qualification Time (TQT) and Guided Learning Hours (GLH)

For all regulated qualifications, we specify a total number of hours that students are expected to undertake in order to complete and show achievement for the qualification – this is the Total Qualification Time (TQT). The TQT value indicates the size of a qualification.

Within the TQT, we identify the number of Guided Learning Hours (GLH) that a centre delivering the qualification needs to provide. Guided learning means activities that directly or immediately involve tutors and assessors in teaching, supervising and invigilating students, for example lectures, tutorials, online instruction and supervised study.

As well as guided learning, there may be other required learning that is directed by tutors or assessors. This includes, for example, private study, preparation for assessment and undertaking assessment when not under supervision, such as preparatory reading, revision and independent research. TQT and GLH are assigned after consultation with users of the qualifications.

The TQT and GLH for this qualification and the two components are shown below:

TQT:

- The *T Level Technical Qualification in Design, Surveying and Planning for Construction* has a TQT value of 1470.
- The Core Component has a TQT value of 810.
- The Occupational Specialist Components each have a TQT value of 660.

GLH:

- The *T Level Technical Qualification in Design, Surveying and Planning for Construction* has a GLH value of 1200.
- The Core Component has a GLH value of 600.
- The Occupational Specialist Components each have a GLH value of 600.

T Level Technical Qualification in Design, Surveying and Planning for Construction			
Total Guided Learning Hours (GLH)		Total Qualification Time (TQT)	
1200 GLH		1470 TQT	
Core Component		Occupational Specialist Component:	
GLH	TQT	GLH	TQT
600 GLH	810 TQT	600 GLH	660 TQT

Technical Qualification aims and purpose

This Technical Qualification is for T Level students who are undertaking the *T Level in Construction: Design, Surveying and Planning*. 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* 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, which means 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.

Threshold competence refers to a level of competence that:

- signifies that a student is well placed to develop full occupational competence, with further support and development, once in employment
- is as close to full occupational competence as can be reasonably expected of a student studying the TQ in a classroom-based setting (for example, in the classroom, workshops, simulated working and (where appropriate) supervised working environments)
- signifies that a student has achieved at least a pass in relation to the relevant occupational specialism component.

Student profile and progression

Students undertaking this Technical Qualification will be 16–19 years old and in full-time education. They will have chosen a T Level as an alternative to A Levels, Applied Generals or an Apprenticeship.

The typical student will likely have:

- A clear idea as to the industry sector they wish to pursue as a career.
- An idea of the type of job role they'd like to explore as a career.
- Taken an active choice not to pursue an Apprenticeship (either due to lack of availability or the wish to remain in full-time education).

This Technical Qualification is intended for students who want to progress to a career in the construction sector, with a focus on Surveying and Design, Civil Engineering, Building Services Design, or Hazardous Materials Surveying. Job roles could include:

- Surveying Technician
- Civil Engineering Design Technician
- Digital Engineering Technician
- Civil Engineering Technician
- Building Services Engineering Design Technician
- Architectural Technician
- Asbestos Analysis Surveyor
- Construction Design Coordinator

- Transport Planning Technician
- Rail Engineering Design Technician.

The jobs available to students will be based on their individual abilities in the construction sector and will be supported by their achievement of this qualification.

Alternatively, students could progress sideways to Level 3 Construction Apprenticeships to develop and gain certification of their occupational competence, or they could progress to higher level Apprenticeships such as:

- Level 4: Construction Site Engineering Technician, Construction Quantity Surveying Technician, Construction Design and Build Technician, Building Services Engineering Technician, Construction Site Supervisor, Acoustics Technician.
- 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.

Where students do 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 should always check the entry requirements for each degree programme with the relevant higher education provider.

Prior learning requirements

There are no formal prior learning requirements for the *T Level Technical Qualification in Design, Surveying and Planning for Construction*.

However, as a Provider, it is your responsibility to ensure the students you recruit have a reasonable expectation of success on the programme. Formal entry requirements are not set by Pearson, but we expect students to have qualifications at or equivalent to Level 2.

Students are most likely to succeed if they have:

- five GCSEs/international GCSEs at grade 4 or above, including English, Maths and Science and/or
- Vocational Tech Award qualification(s) at Level 2 at Pass and above in a relevant subject, e.g. Construction and the Built Environment.

Students may demonstrate the ability to succeed in various ways. For example, they may have relevant work experience or specific aptitude shown through diagnostic tests or non-educational experience.

Transferring between T Levels

We expect some students to switch between T Levels. During Year 1, Providers should consider the degree of overlap between the two T Levels and the remaining time preassessment, to determine if transfers should be permitted. For funding purposes, it is important that students have made a decision about their T Level and occupational specialism by the end of their first year. T Level Core assessments will vary in terms of content coverage, duration, and method, and therefore attainment from one T Level cannot count towards another.

What does the qualification cover?

The Technical Qualification content has been designed from the Outline Content created by the Institute for Apprenticeships and 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 will 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. General Competency Frameworks for T Levels

The General Competency Framework for T Levels articulates the English, Mathematical 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*.

Competencies that can be developed in relation to a specification element of content are referenced in the column next to this content element. 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 and Digital competencies are embedded in both the Core Component and the Occupational Specialist Components of the *T Level Technical Qualification in Design, Surveying and Planning for Construction*. This is so that students are able to demonstrate their knowledge and understanding of these skills over the course of the qualification.

The Maths competencies have been mapped to the Core Component rather than to the Occupational Specialist Components.

General English competencies

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

General maths competencies

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

General digital competencies

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

D1	Use digital technology and media effectively
D2	Design, create and edit documents and digital media
D3	Communicate and collaborate
D4	Process and analyse numerical data
D5	Be safe and responsible online
D6	Code and program

4. 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 be able to 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:

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 sketches and technical drawings for construction details, site layouts and external envelopes of existing buildings and developments.
- Produce rendered drawings and internal plans in response to design briefs and contexts.
- Synthesise information from given case studies, construction projects or site visits.
- Collate documentation for use as part of a simulated tender.
- Generate reports that consider the feasibility of a new development or refurbishment project.
- Present results of a PESTLE analysis to a client for a proposed project.
- Participate in group and class discussions to examine concepts and approaches to produce solutions to construction problems.

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 in groups to collect data during site visits, such as measurements and statistical information.
- 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 such as the new Wembley Stadium and Crossrail 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 of 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 from a site visit 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.
- Participate in interviews and discussions with clients and stakeholders to determine requirements for a construction project.
- Undertake site visits to research local environments to complete land use surveys.
- Examine soil cores to determine geological conditions of a site.
- 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 for a project.

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

Detailed Content

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.

What students need to learn		
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.		
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.	
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.	
1.1.3	The Work at Height Regulations, planning activities, equipment and PPE requirements.	
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.	E2 E4 D2 CS1
1.1.5	The Welfare at Work Regulations relevant to construction projects.	
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.	
1.1.7	The Management of Health and Safety at Work Regulations and risk assessment requirements under Regulation 3 of the legislation.	
1.2 Students must understand the principles of liability.		
1.2.1	Public liability: injury, illness and death of third parties and damage to the property of a third party.	
1.2.2	Employer liability: employee illness, injury, accidents and compensation.	
1.3 Students must understand and apply HSE approved codes of practice.		
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.	

What students need to learn		
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		
1.4.1	The possible implications of and penalties for non-compliance. • Legal and financial: ◦ enforcement, sanctions, loss of reputation, loss of work, corporate manslaughter ◦ magistrates and crown court penalties – fines and imprisonment.	
1.4.2	The possible implications of and penalties for non-compliance. • Ethical and environmental: ◦ duty of care; moral and ethical obligation to keep people safe ◦ obligation to care for the environment.	
1.4.3	The benefits of undertaking safety reviews, including: • reduction in costs • improved reputation of the company • improved employee morale • improved performance in terms of production.	CS3
1.5 Students must understand the development of safe systems of work		
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.	CS3
1.6 Students must understand the need for safety-conscious behaviours used in construction		
1.6.1	Why safety-conscious behaviours produce fewer accidents and incidents.	
1.6.2	The application and implications of: • following safe systems of work • reporting potential hazards • poor housekeeping.	D4
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: • trends in near misses and types of accident • comparison with UK national accident data • discussion with workforce, site safety meetings, interviews and safety committees • suggestions and recommendations for improvements, justified by statistical analysis.	CS3 CS2 CS1

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.

What students need to learn		
2.1 Students must understand material properties, chemical composition, degradation, failure and effects of environmental conditions		
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. • Material properties: mass, density, compressive strength, tensile strength, shear strength, hardness, toughness, stiffness, workability, resistance to moisture/vapour penetration, resistance to degradation/oxidisation. • Chemical composition (structure) of materials: timber, concrete, plastics, metals. • Degradation: natural agents, timber infestation, timber decay, chemical degradation. • Modes of failure: fatigue, creep, buckling, bending, shear. • Effects of environmental conditions: moisture movement, exposure conditions, freeze-thaw, thermal ageing. • Remedial measures to prevent and reduce degradation: special paints, preservatives, special coatings.	
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. • Bricks – facings, Class A engineering, Class B engineering, commons. • Concrete – prescribed mixes, design mixes. • Reinforced concrete – pre-stressed concrete, types of reinforcement, pre-cast, cast in situ. • Concrete blocks – aerated, high-density, insulated. • Mortar mixes – cement mortar, cement lime mortar, coloured mortar. • Plasterboard. • Glass and glass finishes – smart glass (thermochromic, electrochromic, photochromic), laminated, tempered, float, clear, obscured. • Insulation materials – fibreglass, expanded polystyrene, thermal insulation boards, mineral wool, cellulose, straw, polyurethane.	

What students need to learn		
	- Plastics used for polythene damp-proof membranes (DPM), damp-proof courses (DPC), doors and window frames, soffits, bargeboards, fascia, guttering. - Polyvinyl chloride (PVC), unplasticised polyvinyl chloride (uPVC). - Timber and manufactured boards – hardwoods, softwoods, plywood, chipboard, particle board, medium-density fibreboard (MDF). - Roofing materials – slate, concrete, pantile, roofing felt, thatch, ridge, lead flashing. - Engineered timber – glulam beams, engineered joists, engineered beams, eco joists. - Metals: steel (mild, stainless, high-strength), aluminium alloys, copper, brass.	
2.2 Students must understand information associated with mechanical science		
2.2.1	Relationships between, and calculations of, force, work, energy and power.	M2 M3 M4 M8
2.2.2	Energy forms (kinetic and potential) – thermal, solar and chemical.	M3 M4 M8
2.3 Students must understand the structural science of how loads and forces act on buildings		
2.3.1	Forces – tension, compression, shear, bending.	M2 M3 M4 M8
2.3.2	Stress and strain – shear, compressive, tensile.	M2 M3 M4 M8
2.3.3	Loadings on simply supported beams – point, uniformly distributed (UDL).	M2 M3 M4
2.3.4	The material and types of structural element – beams, columns, struts and ties.	
2.3.5	Calculations including forces, stress, strain, Young's modulus and beam reactions.	M2 M3 M4 M8
2.4 Students must understand the principles of electricity		
2.4.1	Generation of electricity, types of power station and their advantages and disadvantages: - non-renewable – coal, oil, gas, nuclear - renewable – solar, wind, tidal/hydro.	
2.4.2	AC and DC voltage, an understanding of the relationship between voltage, current and resistance (Ohm's Law), electrical power, energy, efficiency and work done.	M2 M3 M4 M8
2.4.3	Transformation: - principles of electro-magnetic induction, including transformer equations - applications of transformers: step-up and step-down transformers.	M2 M3 M4

What students need to learn		
2.4.4	Distribution: - voltages and currents - distribution networks: National Grid, Super Grid, local distribution to domestic and industrial users.	
2.4.5	Use of formulae for calculations involving Ohm's Law, power, energy, efficiency and work done.	M2 M3 M4 M8
2.5 Students must understand the principles of heat in design surveying and planning		
2.5.1	Heat transfer mechanisms – conduction, radiation.	M2 M3 M4
2.5.2	Properties of air – air temperature, air density, humidity, air movement.	M2 M3 M4
2.5.3	Condensation – sources of condensation, effects of condensation, types of condensation, methods of controlling condensation.	
2.5.4	Causes of heat loss – through the fabric of the building, ventilation thermal bridging, air changes.	
2.5.5	Factors affecting rates of heat loss – temperature differences, surface area, material heat transfer properties, air change rates.	
2.5.6	Thermal conductivity and resistance – U-values, insulation materials.	M3 M4 M8
2.5.7	Calculations involving thermal conductivity and resistance, heat loss, conduction and convection.	M3 M4 M8
2.6 Students must understand the principles of light in design surveying and planning		
2.6.1	Types of light and flow of light energy: electromagnetic spectrum, artificial and natural light.	
2.6.2	Refraction, diffraction and reflection.	
2.6.3	Glare, directed and reflected light.	
2.6.4	Daylight factor – sky component, externally reflected component and internally reflected component.	
2.6.5	Calculation of illuminance using the inverse square law, including application of units.	M2 M3 M4 M8

What students need to learn		
2.7 Students must understand the principles of acoustics in design surveying and planning		
2.7.1	Frequencies of sound.	
2.7.2	Reverberation and reverberation time.	
2.7.3	Decibels – as a unit of measure, addition of levels of sound, threshold limits.	M3 M4 M8
2.7.4	Comfort levels – noise pollution, personal factors, building regulations, external sources of sound and noise.	
2.7.5	Privacy and approaches to sound insulation – structural elements, controlling flanking sound and use of materials.	
2.8 Students must understand types of earth science and how these impact on design, surveying and planning		
2.8.1	Physical geography – groundwork, water levels, investigation methods, contaminated land, land use.	CS4
2.8.2	Hydrology: • water cycle – evaporation, condensation, precipitation, infiltration, surface run-off • rivers, reservoirs, lakes.	
2.8.3	Geology: • ground conditions, including methods of investigation (bore holes, pits, trenches) • structure of the ground, including types of rocks, soils, clay • groundwater: water tables, springs, watersheds, aquifers.	CS4
2.8.4	Earth forces and natural phenomena, including effects and impacts on the built environment of: • earthquakes – scales and magnitude, earthquake zones • landslides – effects of shear strength of soils, methods of stabilising land (geosynthetic injection, steel or concrete reinforcement, ground anchors) • tidal surges – effects of currents, approaches to reducing effects (storm surge barriers, sea walls, tidal lagoons, closure dams).	
2.8.5	Weather and climate – rainfall, temperatures, sunlight, wind, frost.	M5 CS4
2.8.6	Interpretation of data and completion of calculations related to earth science, simple calculations with data, percentage, volume, length.	M5 M8 D4 CS3

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.

What students need to learn		
3.1 Students must understand the benefits of accurate and appropriate measurement on built environment performance		
3.1.1	Advantages of accurate and appropriate measurement and reporting.	M1 M8
3.1.2	Measurement and reporting of performance indicators – building running costs, flexibility of space, reliability of systems.	M1 M8 CS1
3.2 Students must understand and apply types of measurement and mensuration techniques		
3.2.1	Different types of measurement, techniques for measurement and the units associated with these measurements, including: • electrical • dimensional • sound • force, stress, strain and pressure • temperature.	M3 M4
3.2.2	Students will need to be able to carry out calculations involving measurements and units.	M3 M4 M8
3.3 Students must understand measurement standards, guidance and practice, including measurement rules, their scope and application for design surveying and planning		
3.3.1	New Rules of Measurement: NRM1, NRM2, NRM3.	
3.3.2	Civil Engineering Standard Method of Measurement, Fourth Edition (CESMM4).	
3.3.3	International Construction Measurement Standards (ICMS).	
3.3.4	Application of measurement standards and rules for taking off quantities – bills of quantities, tendering and estimating, budgets and costs.	D4

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.

What students need to learn		
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		
4.1.1	On-site construction methods: • brick and block • frame – portal; steel, concrete, timber • container • green oak • straw bale • cross-laminated timber (CLT) • use of on-site robotics.	
4.1.2	Off-site construction methods: • structural insulated panels (SIPs) • pre-assembled units/elements/foundations • precast concrete sections and cladding panels • pre-assembled structural steelwork • steel framing systems (SFS) • complete or modular units • framed panels (timber, steel) • sandwich panel systems • concrete panels/sections (including flatpack) • 3D printing • 3D volumetric modules • construction-integrated manufacturing (CIM).	
4.1.3	Building renovations and refurbishment: • structural – extensions, changes of use • cosmetic upgrades • direct replacements.	
4.1.4	Sustainable energy provision within new and existing buildings.	

What students need to learn		
4.2 Students must understand the 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		
4.2.1	Sub-structures – foundations, basements, retaining walls, excavations.	
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).	
4.2.3	Superstructures – frames (timber, steel, concrete, portal), roofs, floors, internal and external walls, windows and doors.	
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.	
4.2.5	External works – drainage, landscaping, parking, paving, perimeter boundaries (fences, walls).	
4.2.6	Infrastructure - roads, bridges	
4.3 Students must understand current building regulations and their purpose, and how they are applied in construction and renovation.		
4.3.1	Approved documentation: • structure – Approved Document A • fire safety – Approved Document B • site preparation and resistance to contaminants and moisture – Approved Document C • toxic substances – Approved Document D • resistance to sound – Approved Document E • ventilation – Approved Document F • sanitation, hot water safety and water efficiency – Approved Document G • drainage and waste disposal – Approved Document H • conservation of fuel and power – Approved Document L • access to and use of buildings – Approved Document M • electrical safety in dwellings – Approved Document P • materials and workmanship – Approved Document 7.	

What students need to learn		
4.4 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		
4.4.1	British Standards – current standards for electrical installations, gas, waste management, Building Information Modelling, fire safety.	
4.4.2	International Standards Organisation (ISO) – current standards for structures, building materials, energy performance and sustainability, heating, cooling and lighting, fire safety.	
4.4.3	Common Minimum Standards for Construction (CMS) – for public sector construction projects.	
4.5 Students must have an understanding of the role of manufacturers' instructions and their purpose in ongoing maintenance and renovation of the built environment		
4.5.1	Types of manufacturers' instructions: • installation instruction manuals • operation and maintenance manuals • commissioning manuals.	
4.5.2	The integration of manuals and information within a Building Information Modelling (BIM) environment.	D3 D4 D5

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.

What students need to learn		
5.1 Students must have an understanding of how data is used during the design, construction, operation and decommissioning of buildings and structures		
5.1.1	Accuracy and precision of data.	M5 M6 D4
5.1.2	Generalisation – layers of data, trends, representative data.	M5 M6 D4 CS4
5.1.3	Interoperability – exchange of data, use of data in Building Information Modelling (BIM) systems and building management systems.	M5 M6 D4 CS3
5.1.4	Level of detail and metadata – data about projects, data about information flows.	M5 M6 D4
5.2 Students must understand the implications and purpose of information standards, regulation, guidance and practice for the construction industry		
5.2.1	Construction Operations Building Information Exchange (COBie) – facilities management, common formats and coding of data.	
5.2.2	Standards – Construction Industry Council (CIC) BIM protocol.	
5.2.3	Data management – regulation, security of data, reasons for standards, compliance with guidance and practice.	
5.3 Students must understand the characteristics and applications of the following sources of information when applied to construction activities		
5.3.1	Data sources for identification of contaminated land – site surveys, desk-based surveys.	D4 CS4
5.3.2	Use of Land Registry data – freehold and leasehold data, land values.	D4
5.3.3	Data sheets – material specifications, system components, operational data, manufacturers' specifications.	D4
5.3.4	Weather and climatic data – rainfall, wind speed, temperature, days of frost, hours of daylight.	D4 CS4
5.3.5	Maps – local geological maps (desktop research), climate maps.	CS4

What students need to learn		
5.4 Students must understand the importance of data management and confidentiality		
5.4.1	Current data protection legislation.	D4 D5
5.4.2	Typical organisational procedures – information flows, shared files/systems, types of information.	D4 D5
5.4.3	Legal responsibilities related to data collection and use.	D4 D5

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.

What students need to learn		
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		
6.1.1	Data capture in a completed building.	D4
6.1.2	Utilising data for manufacture and delivery, and machine-to-machine learning.	D4 D5
6.1.3	Smart homes and buildings – building management systems, lighting, heating, security systems, entertainment systems.	D3 D5
6.1.4	Smart applications for building and urban space management and real-time monitoring.	
6.1.5	The link to sustainability of buildings, systems and energy monitoring.	
6.1.6	Crowdsourcing – collaborative working, sharing ideas, problem solving, design thinking.	CS3
6.1.7	Modelling and analysis – digital data to assist structural analysis, BIM modelling, old information used to support new plans, visual modelling.	D1 D4 CS3
6.1.8	Information interdependencies – cloud computing and storage, sensors, access to common data feeds, project management, just-in-time asset management.	D4
6.1.9	Asset management – Radio-Frequency Identification (RFID) tags, embedded monitoring sensors in materials.	
6.2 Students must understand how digital engineering techniques are used in design, surveying and planning activities		
6.2.1	Simulation – structural analysis, failure mode analysis and digital twins.	D1 D2 CS3
6.2.2	Animation – walkthroughs, fly-throughs, visualisation of structural behaviour and simulation of system operations.	M6 D1 D2 CS3
6.2.3	CAD modelling – 2D drawings, 3D models, rendered images and manipulation of images.	M6 D1 D2 CS3
6.2.4	Surveying – GPS total stations, laser levelling, laser measuring devices and digital theodolites.	CS4

What students need to learn

6.3 Students must understand the benefits of using technologies from other industries and how the construction industry is incorporating these technologies.

6.3.1	3D scanning – renovation/printing of houses, replacement components and visualisation of existing features.	M6
6.3.2	Drones – surveying (including difficult access, dangerous conditions and thermal imaging), site security, site inspections and virtual walk-arounds.	
6.3.3	Geo surveying – laser geo-scanning.	
6.3.4	Just-in-time construction.	

Content Area 7: Construction mathematical techniques

Students must be able to apply an understanding of a range of mathematical 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.

What students need to learn		
7.1 Students must be able to select and apply mathematical techniques correctly to solve construction problems		
7.1.1	Areas, volumes and perimeters of 2D and 3D shapes: - Regular shapes – rectangles, trapeziums, triangles, circles and regular polygons - Irregular shapes – with straight and curved edges - Compound shapes – combinations of whole and partial simple shapes. - Diameter, circumference and radius of a circle.	M2 M3 M4 M7 M8
7.1.2	Pythagoras' theorem.	M2 M3 M4 M7 M8
7.1.3	Trigonometric techniques: sine, cosine, tangent ratios, sine rule and cosine rule.	M2 M3 M4 M7 M8
7.1.4	Triangle area rules.	M2 M3 M4 M7 M8
7.1.5	Algebraic transformation	M2 M3 M4 M7 M8
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		
7.2.1	Differential calculus: basic differentiation (one step) for polynomial and trigonometric functions.	M2 M3 M4 M8
7.2.2	Integral calculus: - indefinite and definite integration techniques (one step) for polynomial and trigonometric functions - constant of integration and initial conditions.	M2 M3 M4 M8
7.2.3	Numerical integration: Simpson's Rule, Mid-Ordinate Rule, Trapezoidal Rule	M2 M3 M4 M8

What students need to learn		
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		
7.3.1	Averages and central tendency: mean, median and mode.	M2 M3 M4 M5 M6 M8
7.3.2	Dispersion: range, standard deviation.	M2 M3 M4 M5 M6 M8

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.

What students need to learn		
8.1 Students must understand the benefits of good design, including delivering within budget, to product performance		
8.1.1	Design to make best use of efficient heating, keeping heat inside the building.	
8.1.2	How good design and materials use leads to better saleability and general uplift to the area.	
8.1.3	How simple, affordable improvement in design gives a better quality of life.	
8.1.4	Efficient use of all light in the design to improve quality of life.	
8.1.5	Use of good design to improve productivity and wellbeing of workers.	
8.1.6	How good design can deliver project outcomes within budget.	
8.1.7	Layout and efficient use of space.	
8.2 Students must understand the principles of design for a construction project		
8.2.1	Aesthetics of design: • use of design features to provide symmetry • use of repeated elements • proportion of design features • use of contrasting materials to provide emphasis • use of colour and texture • integration of elements to provide continuity of design.	CS3
8.2.2	Buildability: • ability to construct within a short timescale • provision and integration of services • identification of clashes and solutions • opportunities to incorporate modern methods of construction.	CS3
8.2.3	Spatial requirements of buildings: • provision of space for services • provision of space for access.	CS3

What students need to learn		
8.2 Students must understand the principles of design for a construction project		
8.2.4	Environmental protection and sustainability: • use of sustainable technologies and solutions • use of sustainable materials • energy reduction technologies and systems • designs sympathetic to the local natural environment • impact of floods.	CS3
8.2.5	Safety: • allowing safe construction methods • safety requirements for the client and end user.	CS3
8.3 Students must understand the design process for construction projects, from conception to completion		
8.3.1	Functional factors: • how the building operates within its defined use • the project's spatial requirements – building size, layout, circulation space, number of floors, number and use of rooms • future-proofing of designs: extension potential to meet residential needs and business expansion, flexibility and remodelling potential • external and internal aesthetics • types and use of materials • sustainability, energy efficiency, alternate types of energy sources and sustainable technologies • target market sector – age demographic of the building user(s), needs of different building users, corporate image and branding requirements • security requirements for the building and client operations life expectancy – design life of buildings.	CS3
8.3.2	Site information factors: • site features – location, size, configuration, orientation, access, topography, flood risk • borehole report used to provide information on geotechnical and ground conditions • contaminated land • building services availability • existing buildings and structures • neighbouring structures and the need for temporary and permanent support • restrictions – trees and tree preservation orders, rights of way/wayleaves and underground transport.	E3 CS3

What students need to learn		
8.3.3	Planning factors: • planning consent/approval • local plan requirements • being sympathetic to the local environment • planning objections and pressure groups • listed building consent • 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).	E3 CS3
8.3.4	Statutory constraints and their requirements and impacts on inclusivity: • Equality Act • Access to and use of buildings – Approved Document M • restrictive covenants on land and property.	CS3
8.3.5	Indoor Environmental Quality (IEQ), covering: • indoor air quality • thermal comfort • lighting • acoustics.	CS3
8.3.6	Social constraints: • neighbours' rights – shared access, not being overlooked • local community objections • green space requirements • environmental requirements • mixed and balanced development.	CS3
8.3.7	Project budget and economic constraints: • cost/benefit analysis • local land prices • available funds • sources of additional funding for business premises – grants, government incentives • home ownership and funding – shared-ownership schemes and government incentives for developers and buyers • funding of infrastructure projects - local authority, government, private investment • life cycle costs.	D1 D2 CS3

What students need to learn		
8.3.8	Stages of the design process for construction projects: • definition of the project • establish client needs • feasibility study • concept designs • detail design • production information • ongoing design development	
8.4 Students must understand the principles and benefits associated with a life cycle assessment (LCA)		
8.4.1	Stages of life cycle assessment in construction: • raw material or recycled material supply • manufacture of construction products • the construction process stage • occupation, use and maintenance stage • demolition • material disposal or recycling.	CS3
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		
8.5.1	Manual and CAD drawing techniques, application and use, including: • drawing lines and shapes – regular and irregular shapes, line conventions • drawing to a scale • lettering and dimensioning • 2D drawings, including the use of orthographic projection, schematic plans and layout diagrams, elevations, site layout plans and cross-sections • 3D drawings, including the use of isometric projection, single and two-point perspective.	M1 M9
8.5.2	CAD techniques to produce 2D and 3D drawings: • use of set-up, drawing, editing and zoom commands • setting up floor and external levels • drawing with composite elements • inserting standard components • layers in drawing production • Basic 3D virtual building models, including producing camera views and rendered images.	M1 M9 D1 D2 D3 D5

What students need to learn

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: • electrical and plumbing – basic symbols used in domestic, industrial and commercial installations • ventilation – basic symbols used in commercial and industrial installations • construction materials – basic symbols used in industrial, domestic and commercial installations • construction components – basic symbols used in domestic and commercial installations • civil engineering – basic symbols used in domestic and commercial installations.	
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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.

What students need to learn		
9.1 Students must understand the structure of the construction industry and the activities carried out by different sectors		
9.1.1	Types of activity undertaken by sectors in the construction industry: • sectors – infrastructure, industrial, residential, commercial, health, education, leisure and recreation • design and construction of buildings, structures and infrastructure • refurbishment of existing buildings • repairs and maintenance of buildings • estates and facilities management • demolition of buildings and infrastructure.	
9.2 Students will understand how the construction industry serves the economy as a whole		
9.2.1	The wealth generated by property and land development: • benefits to the UK economy, built environment and local communities • regeneration of inner-city areas.	
9.2.2	The contribution to infrastructure: • transport networks • provision of services – gas, electricity, water and communications technology • water management – drainage, sewer systems, flood defences • renewable energy projects.	
9.2.3	The contribution to the community: • housing – private, social, shared ownership • employment – in construction and the wider community • transport – roads, railways, footpaths, cycle routes, buses • security • industrial and commercial developments. • health - hospitals, health centres • education - schools, colleges, academies • leisure/recreation - parks, communities centres	

What students need to learn		
9.2.4	The benefits to the local community of the redevelopment of brownfield sites: • removal of chemical or toxic contamination • reuse of waste land • economic uplift in the area • environmental protection of local habitats and resources. • improvement of safety and security, removal of anti-social behaviour and general blight.	
9.3 Students will understand the principles of the integration of the supply chain through partnering and collaborative practices		
9.3.1	Inventory management and supply chain components: • logistics activities in the supply chain – materials handling, production, inventory management, transportation and security of supplies • monitoring and controlling inventory – just-in-time supply and Kanban systems in prefabrication and on-site construction.	
9.3.2	Integrating supply chains: • sharing requirements and the need for goods, services and quality standards • integrating computer systems – common data and communication standards, electronic data interchange (EDI) • specifying and agreeing responsibilities of individual businesses.	
9.4 Students must know how projects are procured within the construction sector		
9.4.1	Documentation and basic information required for procurement and tendering: • expression of interest • a letter of invitation to tender • pre-construction information • a tender pricing document • design drawings • specifications • bills of quantities • schedules – schedules of work, activity schedules • emerging modern methods of construction.	E1 E2 E3 E4 E5 E6 M8 D4 D5 M9 M10

What students need to learn		
9.4.2	Students must understand types of procurement, how the client and contractors interact within the supply chain and who holds the commercial risk: • traditional contract • single-stage and two-stage design and build • construction management • custom build • emerging cost contracts • fast-track construction • guaranteed maximum price • lump sum contract.	M9 M10 CS2
9.5 Students must understand the principles and application of quantification and costing		
9.5.1	Application of standards in the production of quantities, including: descriptions for bills of quantities • variations • interim payments • final account work • claims and disputes • cost-reporting guidance notes.	E2 E4 M2 M4 D4
9.5.2	Descriptions and quantities used when producing tender documents: • compilation of descriptions for works • mensuration techniques.	
9.6 Students must understand the principles of financial controls and apply these to construction situations		
9.6.1	Calculation of all-in rates for materials, labour and plant are completed, including: • material costs – calculation of material quantities • cost of construction works, based on unit costs of materials • labour rates – calculation of all-in rates for craft workers (skilled, unskilled, gang rates) • application of labour costs in unit rates and hourly rates • plant rates – calculation of fixed and operating costs, units and hourly rates • calculation of unit rates and hourly rates – substructure, superstructure, first fix, second fix • completion of documentation.	M9
9.6.2	Use of rate tables, standard price books, historical rates.	M9

What students need to learn		
9.7 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		
9.7.1	Construction professionals: • contractors • land surveyors • quantity surveyors (main contractors and professional) • hazardous materials surveyors • structural engineers • heating engineers • electrical engineers • civil engineers • building services engineers • architects • project managers.	CS2
9.7.2	Trade professionals: • carpenters • joiners • painters and decorators • bricklayers • ground workers • plasterers • electricians • plumbers • roofers • HVAC technicians.	CS2
9.8 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		
9.8.1	The role of development and CPD to further careers and keep up to date with the current standards and practices: • types of development – apprenticeships, degree apprenticeships, graduate training programmes, higher technical qualifications • types of CPD – in-house training, formal training, updating of qualifications and skills, gaining experience, becoming chartered, progression qualifications, self-learning.	

What students need to learn

9.9 Students must understand how Building Information Modelling (BIM), the Digital Plan of Works (DPoW), Employer's Information Requirements (EIR) and the Common Data Environment (CDE) are used in construction projects and how the exchange of information can affect project delivery

9.9.1	The stages of the RIBA Digital Plan of Work (DPoW) and its application to construction projects: 1. Preparation and brief 2. Concept design 3. Developed design 4. Technical design 5. Build and commission 6. Handover and close out 7. Operation 8. End of life.	D1 D2 D3 E6 E4 CS1
9.9.2	The characteristics and protocols associated with BIM and the implementation of BIM within the RIBA DPoW: • enables digital technology design and communication • embeds key product and asset data in all project stages • manages information throughout the project life cycle, using three-dimensional (3D) computer modelling • 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 • produces unified information output for the client at handover • provides a model of the building through the life cycle that can be updated • the model is used as part of the decommissioning and recycling of the building at the end of its life.	D1 D2 D5 D3 E1 E2
9.9.3	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: • a construction project's CDE is up to date throughout the life cycle of the building • the content is suitable, accurate and accessible to all.	D1 D2 D5 D3 E1 E2 CS3 CS2
9.9.4	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: Who is sharing information? What information is needed by stakeholders? When is information needed by stakeholders? What is the purpose of the information? What are the effects on project outcome and delivery?	D1 D2 D5 D3 E1 E2 CS2

What students need to learn

9.10 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

9.10.1	Political: these factors determine the extent to which a government may influence the economy or a certain industry. Economic: these factors are determinants of an economy's performance that directly impact on a company and have resonating long-term effects. Social: these factors scrutinise the social environment of the market, and gauge determinants such as cultural trends, demographics and population analytics. Technological: these factors pertain to innovations in technology that may affect the operations of the industry and the market favourably or unfavourably. Legal: the implications of legislation to the project, including contract law, building regulations, building control, HSWA, civil law. Environmental: these factors include all those that influence or are determined by the surrounding environment.	CS3
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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.

What students need to learn		
10.1 Students will understand the importance of sustainability when planning and delivering a construction project		
10.1.1	Minimisation of the impact of construction activities.	
10.1.2	Designing to use sustainable construction methods and materials.	
10.1.3	Use of construction site practices that minimise the effect on the natural and physical environment.	
10.1.4	Reduced reliance on finite fuels and natural resources.	
10.1.5	Designing for future effects of climate change.	
10.1.6	The Green Guide to Specification.	
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		
10.2.1	Types of sustainable solution: • straw bale construction • timber framed/panelled construction • modular and pre-fabrication construction techniques • use of thermal mass within buildings to absorb and emit heat • use of low embodied energy materials • insulation • water saving solutions • use of Sustainable Urban Drainage Systems (SUDS) • energy-efficient heating, ventilation and lighting systems • glazing – smart glass, double/triple glazing, low-emissivity glass • use of materials to enable easier recycling at the end of their life.	

What students need to learn		
10.2.2	How sustainable materials are used in sustainable solutions: • 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) • roofing materials – thatch and reconstituted slates • insulation materials – recycled glass mineral wool, sheep's wool insulation, hemp and flax • recycled building materials – crushed hardcore from demolition, recycled bricks, recycled slates.	
10.2.3	Embodied energy Code for Sustainable Homes ratings (the code continues to operate for legacy buildings) Embodied energy of construction materials Factors that contribute to embodied energy – extraction of resources, processing, assembling, transportation, construction, maintenance and repair, demolition, disposal	
10.3 Students must understand obligations under environmental legislation		
10.3.1	Current environmental law that concerns the protection of the environment in the United Kingdom with respect to: • climate change • biodiversity • the Clean Air Act • the Water Act • the Wildlife and Countryside Act.	
10.3.2	Ground contamination: • surveying of potentially contaminated land • types of contaminant, including radioactive, toxic and biological (including non-native plant species) • safe disposal of waste material, including radioactive, toxic and biological (including non-native plant species) • treatment of contaminated land for radioactive, toxic and biological contaminants • containment of contaminants.	CS4

10.4 Students must understand environmental policies, initiatives and performance measures, and how they impact on design and construction		
10.4.1	Conservation of fuel and power – Approved Document L.	
10.4.2	Environmental and sustainability assessment tools: • Building Research Establishment Environmental Assessment Method (BREEAM). • CEEQUAL • Home Quality Mark	
10.4.3	Government subsidies for using environmental technologies.	
10.4.4	Environmental Performance Certificate (EPC) to rate a building on its energy usage and carbon footprint.	

What students need to learn		
10.5 Students must understand the principles of heritage and conservation within a construction environment		
10.5.1	Restrictions associated with listed and historical buildings: • listed building grading – Grade I, Grade II* and Grade II • permissions for buildings to be demolished, extended or altered • notification of work to a listed building that involves any element of demolition.	
10.5.2	Legislation and guidance relating to listed buildings and heritage sites: • Planning (Listed Buildings and Conservation Areas) Act • Heritage Protection Bill.	
10.6 Students must understand the principles of 'lean construction' and how it applies to the construction industry		
10.6.1	Aims of lean construction: • eliminating waste and errors through reduction, recycling and repurposing • improving work planning and forward scheduling • identifying the processes that deliver best value • eliminating activities that do not add value • ensuring the working environment is clean, safe and efficient • continuous improvement • just-in-time deliveries.	CS3
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		
10.7.1	Plan safe transportation and disposal of waste: • the categorisation of waste materials for general disposal • specialist disposal of hazardous waste • using licensed disposal contractors • incineration for specialist disposal • use of Environment Agency registered waste carriers.	CS3
10.7.2	Plan methods to minimise pollutants associated with construction-related activities: • how to reduce the noise from construction operations (use of silencers, maintenance of machinery) • 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) • reduction of high carbon emissions created during the manufacture of high energy materials	CS3

What students need to learn		
	- reduction of dust from excavation and demolition work (damping down, road sweeping, use of dust suppression equipment, wheel cleaning) - 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).	
10.8 Students must understand the advantages of alternative methods of energy production and the impact of energy use		
10.8.1	Ground source – ground source heat pump (horizontal and vertical).	
10.8.2	Air source – air source heat pump (indoor heat exchanger, outdoor heat exchanger, air to air, air to water).	
10.8.3	Wind – micro wind generator (horizontal axis, vertical axis).	
10.8.4	Solar – solar photovoltaic (PV) panels, solar panels (thermal).	
10.8.5	Combined heat and power.	
10.8.6	Biomass fuel heating systems.	

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.

What students need to learn		
11.1 Students must understand roles, expectations and interrelationships of different stakeholders throughout the construction project delivery		
11.1.1	Types of stakeholder – client, construction team, community and end user.	E1
11.1.2	Expectations and interrelationships of different stakeholders during stages of a construction project: • during the start of a project • during the design stage • during the construction phase • at the handover of the project • once the project is completed and in use.	E1 CS2 CS1
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		
11.2.1	Collaborative approaches during project delivery: • delivery – meeting deadlines and specifications • reporting – awareness of progress and issues • presenting information and ideas to technical and non-technical audiences to convey different project information • summarising information – requesting information and recording for later use • synthesising information – using more than one source to interpret and respond to different situations.	E2 E4 E5 CS2

11.3 Students must understand the principles and importance of customer service		
11.3.1	Importance, implications and benefits of building good customer relationships: • enhanced reputation of business • repeat business • customer confidence in business • job satisfaction for employees.	CS1
11.3.2	Principles of customer service: • good communication, meeting agreed timescales, timely customer responses and monitoring of progress • good product knowledge – building trust and meeting expectations.	CS1
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		
11.4.1	Positive effects of good teamwork: • improved efficiency and performance • less reliance on managers to make decisions in response to changing circumstances • high levels of staff morale • improved innovation and willingness to suggest new ideas • complementary skills sets • mutual accountability.	E1 CS2
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		
11.5.1	Qualities and characteristics of an effective team and team members: • effective communication between team members • increased morale • knowledge of organisation, product and service • organisation in job roles – clear leadership, defining job roles and responsibilities • adaptable/flexible approach • working to team members' strengths and weaknesses.	E2 E6 CS2
11.6 Students must understand the importance of equality, diversity and representation, including related legislation		
11.6.1	Legislation: Equality Act, Employment Rights Act, Human Rights Act.	
11.6.2	Trade unions – right to representation, right to membership.	

11.7 Students must understand negotiation techniques and how they are used when taking part in discussions with clients, contractors and other relevant stakeholders		
11.7.1	Negotiation techniques: • win-win • lose-lose • I win, you lose • I win/lose some, you win/lose some • I lose, you win.	E6 CS1
11.8 Students must understand conflict management techniques		
11.8.1	Conflict resolution techniques: • collaborating or problem solving • compromising • smoothing • forcing • withdrawing or avoiding • mediation.	CS1 CS2 CS3
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		
11.9.1	Formal and informal styles of communication to convey technical information to different audiences: • discussions with the client • communicating information to stakeholders – local authority, general public, planning notices and applications.	E1 E2 CS1
11.9.2	Methods of verbal and non-verbal communication: • verbal – pitch and tone of voice, open and closed questions, using the telephone, presentations • non-verbal – written, sign and body language, listening skills.	E1 E2 E4 E6 CS1
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.	E1 E2 E4 E6 CS1 CS2

11.10 Students must understand employment rights and the responsibilities of the employer and employee		
11.10.1	Employment rights available to all employees, including: • national minimum wage, national living wage, illegal deductions, timing of payment, pension • health and safety • time off – holiday entitlements (full- and part-time employees), time off for trade union duties, weekly and daily rest breaks • access to a trade union representative in the event of a grievance • not being harassed or discriminated against • maternity leave, paternity leave and unpaid parental leave.	
11.10.2	Responsibilities of employers and employees: • employer to an employee – providing work, pay and health, safety and welfare compliance • employee to an employer – obeying reasonable instructions/orders, not stealing, complying with health and safety requirements.	
11.11 Students must understand ethics and ethical behaviour as applied to working in the construction industry		
11.11.1	Ethics and ethical behaviours: honesty, fairness and equality.	
11.12 Students will understand how using sources of information, including social networking, contributes to knowledge sharing		
11.12.1	Use of information, including web-based sources for knowledge sharing with stakeholders: • collaborating on ideas using social networking • promoting products and services through social media and advertisements • gathering customer feedback.	CS2

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.

What students need to learn		
12.1 Students must understand types of business structure and the roles each may play in a construction project		
12.1.1	Types of business structure: • small and medium enterprises (SMEs) • private – including sole partnerships, partnerships, limited liability, corporations • not-for-profit: community interest companies (CIC), public organisations.	
12.2 Students must understand business objectives of organisations in the construction industry		
12.2.1	Financial business objectives: • private organisations – profitability, growth, market leadership • not-for profit-organisations – alleviating poverty, cost control, value for money.	M6 M9
12.2.2	Social business objectives: • private organisations – provision of employment • not-for profit-organisations – provision of education, provision of housing, provision of healthcare, service provision, service quality, meeting government standards.	M9
12.3 Students must understand the need for business values and ethical and transparent business practices		
12.3.1	Commitment to customer service.	
12.3.2	Environmental values: Fair Trade, Forestry Stewardship Council (FSC).	
12.3.3	Company code of conduct.	
12.4 Students must understand the principles of corporate social responsibility		
12.4.1	Approaches to corporate social responsibility (CSR): • incorporating sustainable development into a company's business model • positive impacts on social, economic and environmental factors • use of local resources – local trades, local suppliers and locally produced materials • community design – community-led designs, inclusive design.	

12.5 Students must understand the role of innovation and entrepreneurship within the construction industry		
12.5.1	Innovation and entrepreneurship: • product or service development • successfully exploiting a new idea • adding value to buildings and structures to differentiate the project from the competitors • having a vision for opportunities to develop projects.	
12.6 Students must understand how businesses measure success		
12.6.1	Key performance indicators (KPIs), including their use with target setting: • input KPIs – purchases made, resources, funding for training • process KPIs – efficiency or productivity, average daily rate, production time • output KPIs – gross/net profit margin, operating margin, return on investment.	CS1
12.6.2	The characteristics of benchmarking and target setting as a measure of success, including: • meeting/exceeding client expectations • clearly defining the service level agreement (SLA) • setting the performance standard required.	CS1

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.

What students need to learn		
13.1 Students must understand the principles of project management		
13.1.1	The common roles and responsibilities of stakeholders, project teams and the project manager.	
13.1.2	Principles of project management – goals, objectives, milestones.	
13.2 Students must have an understanding of the importance of quality management techniques used in the construction industry		
13.2.1	Quality management techniques: • quality assurance and control • total quality management • benchmarking • continuous improvement process • value engineering.	
13.3 Students must understand approaches to project management throughout the whole life cycle and work stages of a construction project		
13.3.1	Stages of the project management life cycle: • initiation – identification and justification of project need, assessing the size, scope and feasibility of the project • planning – establishing project requirements (costs, schedule, deliverables, delivery dates), resources, quality, communication planning and risk analysis • execution – status and tracking, quality, KPIs, forecasting • performance and control – objectives, quality deliverables, cost tracking • closure – snagging, reporting, lessons learned.	CS3
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.	CS3

What students need to learn		
13.4 Students must understand the management of the procurement process		
13.4.1	The characteristics of the following procurement routes: • traditional/conventional • design and build • management • integrated.	
13.4.2	Common methods of tendering and how to create texts for different purposes and audiences: • methods of tendering relevant to the scale, size and value of the construction works • types of work tendered for (building, civil engineering, surveying and building services work).	E3 E5
13.4.3	Documentation required for procurement and tendering, and how to create texts for different purposes and audiences, including: • drawings, such as site layout plans • schedules – schedules of work, activity schedules • specifications • bills of quantities • method statements.	E3 E5 CS1
13.5 Students must understand the principles of project, construction and commercial risk management		
13.5.1	Commercial risk for clients and contractors: • client risk – ensuring funding, potential profit analysis • contractor risk at tender stage – the need for an accurate bill of quantities, safety margins, timescales.	CS3
13.5.2	Risk management techniques: • identification of risks • reviewing and monitoring risks • mitigation techniques.	CS3

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.

What students need to learn		
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		
14.1.1	Case law – a set of past rulings by tribunals that meet their respective jurisdictions’ rules to be cited as precedent.	
14.1.2	Legislation – a law that has been enacted by a legislature or other governing body, or the process of making it.	
14.1.3	Civil law – a body of rules that defines and protects the private rights of citizens.	
14.1.4	Criminal law – the body of law that relates to crime.	
14.2 Students must understand the principles and implications of land law with respect to the built environment		
14.2.1	Different types of land ownership: • sole proprietor/owner • government/council owned • concurrent ownership – joint tenancy, joint mortgages, rights of survivorship, the four unities (time, title, interest, possession), shared ownership, tenants in common.	
14.2.2	Features of leasehold and freehold ownership and the differences between them.	
14.2.3	Legislation and regulations impacting on use of land and buildings: • implications for construction where there are boundaries and party walls • planning regulations • easements and wayleaves.	
14.3 Students must understand the permissions required to undertake survey work, and the implications of non-compliance		
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).	

What students need to learn		
14.4 Students must understand the implications of the law of contract for construction projects, including the scope of types of contract		
14.4.1	Types of contract used in construction: • Joint Contracts Tribunal (JCT) • Association of Consultant Architects (ACA) Building Agreement • ICE conditions of contract • International Federation of Consulting Engineers (FIDIC) • New Engineering Contract (NEC).	
14.4.2	Implications of law on contracts used in construction: • rights and obligations under contracts • conditions of contract • variations in construction contracts.	
14.5 Students must understand case law related to the law of tort and the law of landlord and tenant, including duty of care		
14.5.1	Law of tort – liabilities, civil liability for damages, negligence.	
14.5.2	Law of landlord and tenant – duties of landlords, duties of tenants, leases, eviction, damages, rents.	
14.6 Students must understand the implications of building regulations, and of breaches of or failure to comply with building regulations for the construction project and key stakeholders		
14.6.1	Implications of the failure to comply with building regulations: • implications for stakeholders – prosecution (financial penalties, prison sentences), damage to reputation • implications for the project – impact on selling property, enforcement notices.	
14.7 Students must understand the importance, implications and ways of protecting intellectual property rights		
14.7.1	Types of intellectual property rights that give automatic protection: • copyright • design rights.	
14.7.2	Types of intellectual property where protection needs to be applied for: • trademarks • patents • registered designs.	

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*:

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

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.

Core examinations

Paper 1: Science and Building Technology
Written examination: 2 hours 30 minutes 33.33% of the Core Assessments 100 marks Graded A* – E
Content overview: 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
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 calculations and questions, as well as drawing questions and labelling questions. • It will be set and marked by Pearson. • It will be timetabled at a time and date specified by Pearson.

Paper 2: Construction Industry and Sustainability

Written examination: 2 hours 30 minutes

33.33% of the Core Assessments

100 marks

Graded A* - E

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.

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

Employer Set Project
Externally assessed project: 15.5 hours 33.33% of the Core Assessments 100 marks Graded A* - E
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.

Employer Set Project

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.

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.

Employer Set Project Assessment Objectives

The Assessment Objectives for the Employer Set Project are as follows:

Assessment Objective	Strand	Descriptor
A01	1. Planning	Plan and research information necessary to present solutions to a brief.
A02	2. Application	Apply knowledge and skills using a logical approach, working with others to identify issues, solve problems and propose solutions.
A03	3. Select relevant techniques and resources	Select relevant techniques and resources to respond to a brief.
A04	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.
A05	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.

5. Occupational Specialist Component: Surveying and Design for Construction and the Built Environment

Content Summary

The Occupational Specialist content is separated into four Performance Outcomes, with the skills needed to achieve threshold competence and the knowledge to underpin skill application across the following areas.

Performance Outcome	Key content areas	Skills
1. Measure the built environment	K1 Law K1.1 Permissions required to undertake survey work, including geospatial K2 Digital technology K2.1 How the Internet of Things contributes to the measurement of the built environment K2.2 Geospatial equipment, their applications, suitability and use K2.3 Digital engineering techniques and appropriate software K2.4 Geospatial information conveyance and sourcing, including GIS, cartographic and other commercially available data K3 Measurement K3.1 Types of measurement and detection K3.2 How to capture, process, manage, use and quality assure data, including geospatial K3.3 Calculations required and how to undertake them K3.4 The principles and limitations of measurement, e.g. parallax	S1.1 Explore requirements of the task, using open questioning and listening. S1.2 Gather information from appropriate sources specific to the scope of works, including Geographical Information Systems (GIS). S1.3 Determine the level of accuracy required. S1.4 Capture data, using appropriate measurement methods. S1.5 Process data, using appropriate techniques. S1.6 Extract and manage data, using appropriate techniques. S1.7 Quality assure the surveying measurements. S1.8 Communicate health and safety risks associated with the task and environment, using appropriate methods.

Performance Outcome	Key content areas	Skills
	K3.5 Techniques used to gather data, including geospatial data, e.g. Global Navigation Satellite Systems (GNSS), photogrammetry K3.6 The importance of coordinating systems, projects, transformations and datums K3.7 Construction industry measurement standards, guidance and practice, including measurement rules K3.8 Good survey practice, e.g. whole to the part, local vs national and error propagation	S1.9 Assess health and safety risks associated with the task and environment. S1.10 Select and use tools and equipment with accuracy and efficiency. S1.11 Operate equipment and perform tasks safely. S1.12 Manage waste, including the quantification, classification and disposal of waste.
2. Analyse the built environment	K4 Project management K4.1 Project programmes K4.2 Digital workflows K5 Sustainability K5.1 Digital workflows K5.2 How and why sustainability seeks to balance economic, environmental and social objectives	S2.1 Sequence and prioritise tasks. S2.2 Analyse information available to determine requirements of the task. S2.3 Interpret information and data, including from visual and other sources. S2.4 Convey data.
3. Design the built environment	K2 Digital technology K2.5 Digital design tools, e.g. computer-aided design (CAD) K2.6 Digital specification tools, e.g. the National Building Specification (NBS), BS 1192 K2.7 Digital data, e.g. spreadsheets and schedules K2.8 Digital presentation, image handling and desktop publishing, e.g. brochures and reports	S3.1 Identify information and data required to complete the task. S3.2 Quality assure information and data, including third-party expertise. S3.3 Conduct precedent research, including best practice, benchmarks and design guides.

Performance Outcome	Key content areas	Skills
	K6 Design K6.1 How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes K6.2 The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent K6.3 The implications of statutory obligations to designs, e.g. utility diversion K6.4 The use and importance of specifications, e.g. as applicable to design guides and legislation K6.5 The relevance of measurement in the design process, e.g. area (net and gross) volume, height and length K6.6 Technical drawing techniques K6.7 Inclusive design, including equality and diversity by impact K7 Health and safety K7.1 The CDM Regulations 2015 and the duties of the designer K7.2 The identification and design of hazards, and risks and methods of assessment, e.g. Design Risk Assessments (CDM 2015) K7.3 Fire and emergency safety, e.g. the Hackitt Review	S3.4 Use suitable data, quality assured in line with best practice. S3.5 Model design, using digital software and other tools and techniques. S3.6 Present appropriate design information and data, using different methods and formats. S3.7 Manage data in a collaborative environment. S3.8 Communicate design and construction risks, using appropriate methods. S3.9 Manage relationships. S3.10 Provide creative solutions to challenges arising from requirements. S3.11 Adapt design proposals in response to design constraints and stakeholder feedback, in terms of time, cost and material factors.

Performance Outcome	Key content areas	Skills
	K8 Relationship management K8.1 Negotiation, mediation and conflict management techniques, and their suitability for different situations K8.2 Consultation requirements, e.g. the expertise and input of third-party knowledge K8.3 Processes of collaborative design, e.g. coordination of team input and clash management	
4. Verify delivery of the built environment	K3 Measurement K3.9 Types of measurement for the combined data K3.10 Techniques for value engineering K3.11 Rules of measurement and contractual implications K5 Sustainability K5.2 How and why sustainability seeks to balance economic, environmental and social objectives K5.3 Legal obligations relating to pollution and waste. K5.4 Environmental performance measures that must be met and how they are measured K5.5 Principles of heritage and conservation K9 Valuations K9.1 Industry valuation standards, guidance and practice and how these are used to verify delivery of the built environment K9.2 Valuation benchmarking and how this is used to verify delivery of the built environment	S4.1 Verify suitability of information and data from appropriate sources specific to the scope of works. S4.2 Interpret information and data, including from visual and other sources. S4.3 Present information, using oral, visual and written communication. S4.4 Use software with accuracy to verify specific items, utilising appropriate tools. S4.5 Complete costings analysis through the use of market rates and spreadsheet software, including best value and whole life costing. S4.6 Apply appropriate mathematical techniques in a construction context.

Detailed content

The detailed content for each Performance Outcome represents the different activities and associated skills performed in Surveying and Design for Construction and the Built Environment. Each skill has underpinning knowledge to support skill application.

Performance Outcome 1: Measure the built environment

1.1 Preparation for task, desk study and building survey

Skill content	Knowledge
S1.1 Explore requirements of the task, using open questioning and listening.	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: (E2, E3, E4, D3, K2.2) • relevant legislation relating to survey work: (K1.1) ○ Civil Aviation Authority (CAA) permission ○ permissions from landowners or controllers of land ○ restrictions for filming in public areas • survey terminology, e.g. back sight, fore sight, datum, reduced level, control points, base line, azimuth, zenith angle, offset, check lines, bearings. Students will explore different types of survey method: • topographical • geological • linear • structural • ecological • boundary • façade • ground • measured.
S1.2 Gather information from appropriate sources specific to the scope of works, including Geographical Information Systems (GIS).	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: (K2.1, K2.3, K2.4) • Ordnance Survey maps • Printed and online maps • Geographic Information System (GIS) • Historic maps and drawings • Cartographic information • Other commercially available data.

Skill content	Knowledge
	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, K2.2, K2.3, K2.4) • desk study • smart buildings • topographical data, including photographic mapping • building information management automated monitoring. Students will learn how to capture, process, manage, use and quality assure data, including geospatial: (E1, E2, E3, E4, E5, K2.2) • limitations of use – cost, accuracy, training requirements, accessibility • measurement standards, guidance and practice, including measurement rules • point cloud surveying, 3D surveys, laser scanning, data collection, cloud to cloud meshed and surfaced models.
S1.3 Determine the level of accuracy required.	Students will study the application, suitability and use of geospatial equipment in a construction context. This will include: (K2.2, K2.3, K2.4) • the principles and limitations of measurement • units of measurement, using appropriate units and contractual arrangements, BS 5606 • converting between common alternative units – degrees, minutes and seconds from decimal measurements, imperial to metric • scientific principles – temperature, atmospheric conditions and how they affect measurements • point density requirements for laser scans • standard units, planning surveys to minimise errors • point marking and control points. Students will understand the importance of coordinating systems, projects, transformations and datums: (K3.6, K3.7, K3.8) • 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 • datum terminology: ○ Ordnance Survey Benchmark (OSBM) ○ Temporary Benchmark (TBM) ○ reduced level. • offsetting, triangulation, base lines • positioning of profiles, control points, TBMs.

Skill content	Knowledge
S1.8 Communicate health and safety risks associated with the task and environment, using appropriate methods. S1.9 Assess health and safety risks associated with the task and environment.	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, K3.2, K3.3, K3.4) Type of accidents and ways to avoid them: • falls from height: ○ 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. 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 ○ 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

Skill content	Knowledge
	• 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: ○ secure the site – netting, signage. • Completion of risk assessment and method statements.

1.2 Collection of survey data

Skill content	Knowledge
S1.10 Select and use tools and equipment with accuracy and efficiency.	Students will understand good survey practice. (K3.1, K3.2, K3.3, K3.4, K3.5, K3.6, K3.7, K3.8) • Whole and part, local versus national and understand the types of error to support error propagation: ○ how errors impact on the accuracy of fieldwork surveys ○ plastic tapes – stretching ○ levels – calibration errors ○ theodolites: – bubble and electronic plummets off-centre errors – horizontal collimation errors – vertical collimation errors ○ electronic distance measurement: (D1) – scale and index errors ○ performance of systematic checks on surveying instruments: – tapes (calibration against standardised steel tapes) – levels (two-peg test) ○ theodolites – vertical axis check – transit axis check – spire check. • The principles and limitations of measurement. (K3.4) • Calculations required. (K3.3) • Adjustment of errors, closing the survey/traverse. • Geospatial equipment; its applications, suitability and use. (D1) (K2.2) • Traditional equipment: total stations, theodolites, levels (automatic, spirit, water), tapes. • Laser levels, mobile mapping, 3D laser scanning, Global Navigation Satellite System (GNSS) (GPS, GLONASS, Galileo etc.) (D1) (K5.5) • Drone surveys, antennae and accessories. (D1)

Skill content	Knowledge
S1.4 Capture data, using appropriate measurement methods. S1.11 Operate equipment and perform tasks safely.	Students will understand types of measurement and detection method. (K3.1, K3.2, K3.3, K3.4, K3.5, K3.6) Students will understand linear measurements, offsets, heights, points, angular measurements (circle bearings, inclination), contouring, gridding. Students will understand methods of collecting and recording data, including manual methods, data collectors, mobile apps. (D1) (D2) (D3) (D4) • Good survey practice, e.g. whole to the part, local versus national, error propagation, reducing angular errors. • The importance of coordinating systems, projects, transformations and datums. • Offsetting, triangulation, base lines. • Positioning of profiles, control points, temporary benchmarks (TBMs).

1.3 Process survey data

Skill content	Knowledge
S1.1 Quality assure the surveying measurements.	• Checking calibration certificates, closing measurements, checking digital measurements with approximate manual methods, two-peg test. • Calibration and human error; correcting for curvature, sag, slope. (M10) • Survey logs, Internet of Things, e.g. machine to machine. (M6) • Identifying anomalous results. • Adjustment of errors, closing the survey/traverse. • Smart buildings, building information management, automated monitoring.
S1.6 Extract and manage data, using appropriate techniques.	• Primary GIS data capture techniques: (D1, D3, D4, K3.2, K3.3, K3.6, K3.7, K3.8) ◦ using remote sensing and surveying technologies to capture the data, using either raster data capture or vector data capture. • Secondary GIS data capture techniques: (D1, D3, D4, K3.2, K3.3, K3.6, K3.7, K3.8) ◦ using technologies such as scanning, manual digitising, vectorisation and photogrammetry to capture data. • Traditional methods of collecting and recording data: ◦ data collectors, mobile apps.
S1.5 Process data, using appropriate techniques.	• Downloading data into CAD and modelling programs. • Using and incorporating data into drawings. • Calculations required and how to undertake them, using spreadsheets, tables, big data. • Rise and fall, height of collimation. • Traverse adjustment. • Digital engineering techniques and appropriate software. (D5, D4, K2.3) • Area and volume calculations, trigonometry, Pythagoras, addition and subtraction of angles.

Skill content	Knowledge
S1.12 Manage waste, including the quantification, classification and disposal of waste.	Students will apply methods used to quantify site waste produced from excavations, demolition and general site waste: • mathematical techniques: ○ regular areas and volumes ○ irregular areas and volumes ○ trapezium rule ○ mid-ordinate rule ○ Simpson's rule • calculation of waste material from site levelling and cut activities by using grid levels and site contours • how bulking factors are applied to materials • the classification of site waste as hazardous and non-hazardous; disposal methods. (E2)

Performance Outcome 2: Analyse the built environment

2.1 Analysis of construction process

Skill content	Knowledge
S2.2 Analyse information available to determine requirements of the task.	Students will develop an understanding of the information that is required to plan and organise construction activities: (E1, (E2, E4, E5, E2, D1, D2, D4, K4.1) • scoping for a project – inception, assessing client objectives, feasibility studies, cost-benefit analysis • adhering to current legislation – global warming, ethical approach to the built environment • information and documentation: ○ site plans ○ planning constraints ○ resource documents ○ contractor requirements ○ considerate constructors. 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: (K5.2) • embedded energy/carbon, short- and long-term, payback, flexible design, re-appropriation of land and buildings • cost-benefit analysis • whole life, including decommissioning • adhering to current legislation • impact of global warming.
S2.3 Interpret information and data, including from visual and other sources.	Students will understand how information is applied to a project in order to develop accurate plans and programmes of work. (E1, E2, E3, E4, E5, D1, D2, D4, K4.2, K5.2) • Project programs, relevance and techniques for reporting: ○ contractual arrangements ○ embedded energy/carbon, short- and long-term, payback, flexible design, re-appropriation of land and buildings. • How sustainability is embedded into solutions: ○ supply chain – sustainable certification, local supplies, waste management ○ off-site construction methods ○ low-energy solutions, reduced embodied energy ○ water use and removal, including on-site solutions ○ land usage, brownfield sites. • Legal obligations relating to pollution and waste: (K5.3) ○ Environmental Protection Act 1990 ○ Water – The Environmental Permitting Regulations 2010 ○ local enforcement and fines.

2.2 Production of planning documentation for the construction process

Skill content	Knowledge
S2.1 Sequence and prioritise tasks.	Students will plan and programme construction activities for small and medium-sized developments using the following: (D1, D2, D4, K4.1) • long- and short-term programmes • types of reporting: ○ critical path ○ activity lists ○ Gantt charts ○ site storage ○ just-in-time ○ activity lists ○ schedules ○ progress reports ○ health and safety reports ○ waste management plans and reports ○ materials ordering and usage • workforce management techniques • noise and planning constraints, Control of Pollution Act 1974, Sec. 60–61 • cost and time implications, including cash flow, payment schedules and payment terms • constraints: hours of work, site location, area and neighbouring properties, funding, planning.
S2.4 Convey data.	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. (E3, E2, E4, E5, D1, D2, D4, K4.1, K4.2) The relevance and use of digital engineering techniques: • protocols • BIM • BEPs • Employer's Information Requirements (EIR) • Common Data Environments (CDE).

Performance Outcome 3: Design the built environment

Research and production of design brief and proposal

Skill content	Knowledge
S3.1 Identify information and data required to complete the task.	Students will understand how designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programs. (D1, D2, K2.2, K2.3, K5.1, K5.2) • Key considerations: ○ design briefs ○ work stages ○ schedules ○ specifications ○ statutory obligations ○ recommendations ○ programmes. • The design team: (K5.6, K5.7) ○ roles and responsibilities, legal obligations ○ drawing techniques ○ inclusive design, including equality and diversity, impact assessment. • Client brief: ○ outline and detailed proposals ○ pre-contract information ○ communication between the different parties ○ design freeze. • Concept: ○ detailed design ○ production information. • Measurement in design: amounts, volumes, distances. (K5.5) • Principles of heritage and conservation. (K5.3) • Listed buildings, Historic England, National Heritage List. (K5.3) • Conservation areas: designation, management, restrictions.

Skill content	Knowledge
S3.2 Quality assure information and data, including third-party expertise S3.7 Manage data in a collaborative environment. S3.4 Use suitable data, quality assured in line with best practice.	Students will understand about the use, application and land management of design data and information. (D1, D2, D4, K2.2, K2.3) • Key design details: ○ sketch drawings ○ models ○ site plans ○ plans and sections ○ detail drawings ○ schedules ○ non-standard items ○ adjoining structures ○ designs for temporary structures ○ method statements ○ specifications. • The importance of communicating design intent to the client to meet contractual requirements to the construction development team. • Communication between the different parties. • Use of different consultants in pre-construction, construction and post-construction.
S3.9 Manage relationships.	Students will develop an understanding of the importance of relationship management in the work environment and throughout the project development process: (E2, E3, E4, K8.1, K8.2, K8.3) • team development • design team – roles, responsibilities, legal obligations • consultation requirements – third-party expertise, input and knowledge • negotiation, mediation and conflict management techniques • communication planning and meetings • processes of collaborative design, e.g. coordination of team input and clash management.

Skill content	Knowledge
S3.3 Conduct precedent research, including best practice, benchmarks and design guides.	Students will use information and research to develop construction designs: • site plans, plans and sections, detail drawings, schedules, non-standard items, adjoining structures, designs for temporary structures, method statements and specifications • concept production • influencing factors – local vernacular, reference to recent developments, client’s vision, architectural styles • the use and importance of specifications, as applicable to design guides and legislation • environmental performance measures that must be met, and how they are measured (K5.4) • Constructing Excellence, Environmental Management Systems (EMS).

3.2 Production of design information

Skill content	Knowledge
S3.10 Provide creative solutions to challenges arising from requirements.	Students will develop the skills required to adapt and make changes to designs following changes to requirements. (K2.2, K2.3, K6.1, K6.2, K6.3, K6.4, K6.5, K6.6, K6.7) • Client's brief, outline and detailed proposals, pre-contract information, BREEAM. • 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: • understanding the relevance of measurement in the design process – area (net and gross) volume, height and length • ergonomics and anthropometrics, approved documents, standard sizes for materials and components • inclusive design, including equality and diversity, by impact assessment • access for all, flexibility, fitness for purpose, being accommodating, being realistic.

Skill content	Knowledge
S3.5 Model design, using digital software and other tools and techniques. S3.6 Present appropriate design information and data, using different methods and formats.	Students will understand techniques used to produce accurate construction drawings and models: (K2.1, K2.5, K2.6, K2.7, K2.8, K6.6) • 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 (K2.5) • production of manual design section, plan and detail sketches/drawings • use of computer-aided design (CAD) to produce section, plan and detail drawings (K2.5) • types of 2D and 3D CAD • line type, wireframe, surface modelling, solid modelling • Autodesk, SolidWorks, Bentley MicroStation, Archima, SketchUp, TurboCAD (K2.5) • digital specification tools – the NBS (national building specification), BS 1192 • digital data – spreadsheets and schedules (K2.5, K2.6) • digital presentation, PowerPoint, image handling and desktop publishing, brochures and reports. (K2.8)

Skill content	Knowledge
S3.8 Communicate design and construction risks, using appropriate methods.	Students will understand the duties of the designer in relation to design risks, produce designers risk assessments and the CDM regulations: (K7.1, K7.2, K7.3) • 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) • safety schemes in procurement (SSIP) • 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 • 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 • use of red, amber, green lists for items to eliminate, control or encourage within designs • fire and emergency safety – the Hackitt Review, escape routes, compartmentation, alarms, emergency service access (K7.3) • the key outcomes of the Hackitt Review and how they apply to designers (K7.3) • designer safety skills, knowledge and experience • use of Building Information Modelling (BIM) to identify potential hazards during construction and in-use; facilities management.
S3.11 Adapt design proposals in response to design constraints and stakeholder feedback, in terms of time, cost and material factors.	Students will understand how designs sometimes need to be altered and changed following changes in circumstances. These could include: • changes to budget • site conditions • legislative changes • incorrect pre-contract information • issues with material supplies and labour. Students will understand methods used to implement design changes: • architects' instructions – change of orders, confirmation of verbal instructions • production of new contracts and design information • planning alterations.

Performance Outcome 4: Verify delivery of the built environment

4.1 Research and verification of information

Skill content	Knowledge
S4.1 Verify suitability of information and data from appropriate sources specific to the scope of works.	Students will understand verification of appropriate project information: • plans and drawings • contracts and tender documentation • variations • progress reports • site instructions • drawing changes and versions • consultant reports. Students will understand information from appropriate enforcement authorities that could influence the final project: (E1, E2, E3, E4) • planning and building control notices • Health and Safety Executive notices: ○ improvement notices ○ prohibition notices. Students will understand types of measurement for combined data: (K3.9) • checking interfaces • valuations. Students will understand about sustainability: • environmental performance measures that must be met, and how they are measured (K5.4) • principles of heritage and conservation. (K5.5)

Skill content	Knowledge
S4.2 Interpret information and data, including from visual and other sources.	Students will interpret different types of project information. As well as the information above, these could include: • cash flow projections • variations • key performance indicators (KPIs) • project schedules • design statements • contents of the project file • legal obligations relating to pollution and waste management: ○ Environmental Protection Act 1990 ○ Water: Environmental Permitting Regulations 2010 • environmental sustainability assessment methods, BREEAM, BRE Home Quality Mark, Latham Report and Egan Report • Considerate Constructors Scheme (CCS) • requirements of Ultra Site status • consultant reports • financial control (QS) report: ○ budget ○ cost plan ○ contingency funds.
S4.3 Present information, using oral, visual and written communication.	Students will develop an understanding of the different methods to communicate and present project information. These methods can include: (E1, E2, E3, E4, E5, D1, D2, D4) • progress reporting processes • variation documents • extensions of time • presentations • meetings • emails and letters • noticeboards • weekly/monthly/quarterly cost reporting.

4.2 Production of measured quantities and prices for proposed development

Skill content	Knowledge
S4.5 Complete costings analysis through the use of market rates and spreadsheet software, including best value and whole life costing.	Students will learn techniques used in the costing and valuation of construction projects: (E1, E2, E3, E4, D1, D2, K3.10, K9.1, K9.2) • techniques for value engineering, e.g. cost, quality and time, and critical analysis of the process • industry valuation standards, guidance and practice, and how they are used to verify delivery of the built environment • advance payments, retention guarantees, milestone payments, contingencies, claims and damages • whole life cycle costing • selection of plant, materials and equipment • assessing alternatives • cost allocation.
S4.6 Apply appropriate mathematical techniques in a construction context.	Students will complete calculations of areas, volumes, quantities, units and tolerances, as required for the measurement process to be conducted: • production of final quantities and bills of quantities • valuation benchmarking and how it is used to verify delivery of the built environment (K9.1, 9.2) • tender prices, preliminary costs, preambles, measured work, prime costs and provisional sums • identification and analysis of elements and their functions • building up rates and costs • rules of measurement and contractual implications, including RICS rules (K3.11) • final summaries.
S4.4 Use software with accuracy to verify specific items, utilising appropriate tools.	Students will use digital methods as applied to the verification of the built environment. These will include: (D1, D3, D4, D5) • project management software • spreadsheets • quantity take-off software • databases • CAD • BIM.

Scheme of Assessment – Surveying and Design for Construction and the Built Environment

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* consists of four Occupational Specialist Components:

1. Surveying and Design for Construction and the Built Environment

2. Civil Engineering
3. Building Services Design
4. Hazardous Materials Analysis and Surveying.

Students will be able to take **one** of the Occupational Specialist Components as part of their *T Level Technical Qualification in Design, Surveying and Planning for Construction*.

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: Surveying and Design for Construction and the Built Environment
Externally assessed project: 30 hours 100% of the Occupational Specialist Component assessment 180 marks Graded P, M and D
Content overview Students are required to: • measure the built environment • analyse the built environment • design the built environment • verify delivery of the built environment.

Assessment overview

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:

Task 1: Planning a survey

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.

Task 2: Practical surveying

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.

Task 3: Completed pre construction survey, calculations and report to the groundworks contractor

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.

Task 4: Quantity surveying

Students will produce a spreadsheet and valuations for the project.

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.

Timings and scheduling

Task	Assessment session	Assessment scheduling	Time
Task 1	1	Taken in a window of assessment, with the assessment sessions scheduled by the Provider	3h 0m
Task 2	2	Taken in a window of assessment, with the assessment sessions scheduled by the Provider	3h 0m
Task 3	3	Taken in a single session at a time specified by Pearson.	2h 30m
Task 4	4	Taken in a single session at a time specified by Pearson.	3h 0m
Task 5	5	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	3h 0m
Task 6	6	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	3h 0m
Task 7	7	Taken in a window of assessment, with the assessment sessions scheduled by the Provider.	12h 30m

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* Occupational Specialist Component projects consist 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 Outcomes

In this assessment, students will:

Surveying and Design for Construction and the Built Environment		
Performance Outcome	Descriptor	Weightings
1	Measure the built environment	25%
2	Analyse the built environment	23%
3	Design the built environment	25%
4	Verify delivery of the built environment	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.

6. Occupational Specialist Component: 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.

Performance Outcome	Key content areas	Skills
1. Analyse civil engineering solutions	K1 Health and safety	S1.1 Sequence and prioritise individual tasks.
	K1.1 Task-specific risk management, including hazards, risk assessment, controls	S1.2 Identify information and data requirements.
	K2 Sustainability	S1.3 Assess health and safety risks associated with the task.
	K2.1 How sustainability is embedded into solutions	S1.4 Adapt actions to the level of risk.
	K2.2 How and why sustainability seeks to balance economic, environmental and social objectives, e.g. whole life, including decommissioning	S1.5 Select data collection and analysis methods.
	K3 Project management	S1.6 Inspect the suitability of tools and equipment.
	K3.1 Project and construction risk management, e.g. consideration of project management solutions	S1.7 Gather relevant information and data, i.e. relevant to the task.
	K4 Design	S1.8 Use tools and equipment with accuracy.
	K4.1 Inclusive design, including equality and diversity by impact assessment	S1.9 Operate safely and apply good housekeeping.
	K4.2 Methods used to test structures, e.g. stress, aerodynamics	
	K5 Material properties	
	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	
	K6 Structural elements, loading and potential failure	

Performance Outcome	Key content areas	Skills
	K6.1 Beams, frames, walls; effect of different loading conditions and failure of, e.g. beams, walls, frames, struts and ties K7 Maths for structural analysis K7.1 Relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams K8 Structural mechanics K8.1 How structural elements (e.g. beams, columns, frameworks) behave under load K8.2 Structural mechanics problems, e.g. reactive forces, maximum load K9 Mathematical techniques K9.1 Algebra, including indices, logarithms, linear equations K9.2 Trigonometric and standard formulae, including circular and triangular measures K9.3 Elementary calculations and techniques, including integration and differentiation K9.4 Statistical methods, including averages, tendency and dispersion K10 Geology/ substructure beyond the core K10.1 Bore holes, trial pits; groundwater – water table, contamination; ground load bearing capacity K11 Setting out K11.1 Techniques for setting-out points and developing the physical positions of elements of a building from the plan	S1.10 Extract relevant information from appropriate sources. S1.11 Quality assure the processes used to collect information and data against protocols and standards. S1.12 Analyse environments against client brief to identify potential issues and problems. S1.13 Carry out calculations related to the scope of work. S1.14 Use appropriate techniques to check accuracy of analysis. S1.15 Produce sketches based on information and data. S1.16 Model analysed information and data, including geotechnical, structural and materials, as appropriate for audience, using digital software. S1.17 Collate information and data into digital engineering software.

Performance Outcome	Key content areas	Skills
	K12 Earthworks K12.1 Excavation, cuttings, embankments, earth moving equipment and concreting equipment	
2. Design civil engineering solutions	K4 Design K4.3 How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes K4.4 The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent K4.5 The implications of statutory obligations to designs K4.6 The use and importance of specifications K4.7 The relevance of measurement in the design process K5 Material properties 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 K6 Structural elements, loading and potential failure K6.2 Beams, frames, walls; effect of different loading conditions and failure of, e.g. beams, walls, frames, struts and ties	S2.1 Extract relevant information and data. S2.2 Quality assure provided data. S2.3 Conduct precedent research into potential solutions to a problem, including best practice, benchmarks and design guides. S2.4 Think creatively, adapting to challenges arising from requirements. S2.5 Assess commercial risk related to potential solutions. S2.6 Apply mathematical principles to the scope of work. S2.7 Resolve technical issues in the design. S2.8 Select methods to present information. S2.9 Determine performance of materials. S2.10 Use appropriate techniques to confirm validity of calculations.

Performance Outcome	Key content areas	Skills
	K7 Maths for structural analysis K7.2 Relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams K8 Structural mechanics K8.3 How structural elements behave under load K8.4 Structural mechanics problems K9 Mathematical techniques K9.5 Algebra, including indices, logarithms, linear equations K9.6 Trigonometric and standard formulae, including circular and triangular measures K9.7 Elementary calculations and techniques, including integration and differentiation K9.8 Statistical methods, including averages, tendency and dispersion K10 Geology/ substructure beyond the core K10.2 Bore holes, trial pits; groundwater – water table, contamination; ground load bearing capacity K11 Setting out K11.2 Techniques for setting-out points and developing the physical positions of elements of a building from the plan K12 Earthworks K12.2 Excavation, cuttings, embankments, earth moving equipment and concreting equipment K13 Measurements K13.1 Measurement standards, guidance and practice K13.2 Types of surveying equipment	S2.11 Model information, using appropriate digital software and other tools. S2.12 Use appropriate techniques to check accuracy of measurements, including scale and proportion, e.g. Ground Validation Points (GVP), known measurements. S2.13 Draw on a range of media to communicate a design proposal.

Performance Outcome	Key content areas	Skills
	K14 Digital technology K14.1 Digital design tools K14.2 Digital specification tools K14.3 Digital data K14.4 Digital presentation, image handling and desktop publishing	
3. Verify delivery of civil engineering solutions	K5 Material properties 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 K6 Structural elements, loading and potential failure K6.3 Beams, frames, walls; effect of different loading conditions and failure of K7 Maths for structural analysis K7.3 Relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams K8 Structural mechanics K8.5 How structural elements behave under load K8.6 Solve structural mechanics problems K9 Mathematical techniques K9.9 Algebra, including indices, logarithms, linear equations K9.10 Trigonometric and standard formulae, including circular and triangular measures	S3.1 Extract relevant information from provided sources. S3.2 Process geotechnical and structural behaviour and human factors information, and data related to the performance of a proposed solution. S3.3 Interpret information and data, including from visual and other sources. S3.4 Complete technical reports. S3.5 Use digital engineering software with accuracy. S3.6 Complete costings analysis. S3.7 Apply appropriate mathematical techniques to solve structural mechanics problems, including algebra, statistics, trigonometry, calculus.

Performance Outcome	Key content areas	Skills
	K9.11 Elementary calculus and techniques, including integration and differentiation K9.12 Statistical methods, including averages, tendency and dispersion K10 Geology/ substructure beyond the core K10.3 Bore holes, trial pits; groundwater – water table, contamination; ground load bearing capacity K11 Setting out K11.3 Techniques for setting-out points and developing the physical positions of elements of a building from the plan K12 Earthworks K12.3 Excavation, cuttings, embankments, earth moving equipment and concreting equipment K13 Measurements K13.3 Types of measurement for the combined data K13.4 Techniques for value engineering K13.5 Rules of measurement and contractual implications K15 Valuations K15.5 Industry valuation standards, guidance and practice, and how these are used to verify delivery of the built environment K15.2 Valuation benchmarking and how this is used to verify delivery of the built environment	

Detailed content

The detailed content for each Performance Outcome represents the skills associated with performing Civil Engineering activities. Each skill has underpinning knowledge to support skill application.

Performance Outcome 1: Analyse civil engineering solutions

1. Analysis of project information and calculations

Knowledge specific to Performance Outcome 1

The analysis of project information to achieve civil engineering solutions requires underpinning knowledge in the following areas:

- K1** Health and safety
- K2** Sustainability
- K3** Project management
- K4** Design
- K5** Material properties
- K6** Structural elements, loading and potential failure
- K7** Maths for structural analysis
- K8** Structural mechanics
- K9** Mathematical techniques
- K10** Geology/substructure beyond the core
- K11** Setting out
- K12** Earthworks

Skills for Performance Outcome 1

The skills will draw on underpinning knowledge appropriate to the context of the scenario. Please refer to the *Occupational Specialism Civil Engineering – Specimen Assessment Material (SAM)* for an example of how underpinning knowledge can be drawn on to meet skills for Performance Outcome 1.

S1.1 Sequence and prioritise individual tasks.

S1.2 Identify information and data requirements.

S1.3 Assess health and safety risks associated with the task.

S1.4 Adapt actions to the level of risk.

S1.5 Select data collection and analysis methods.

S1.6 Inspect the suitability of tools and equipment.

S1.7 Gather relevant information and data, i.e. information relevant to task.

S1.8 Use tools and equipment with accuracy.

S1.9 Operate safely and apply good housekeeping.

S1.10 Extract relevant information from appropriate sources.

S1.11 Quality assure the processes used to collect information and data against protocols and standards.

S1.12 Analyse environments against client brief to identify potential issues and problems.

S1.13 Carry out calculations related to the scope of work.

S1.14 Use appropriate techniques to check accuracy of analysis.

S1.15 Produce sketches based on information and data.

S1.16 Model analysed information and data, including geographical, structural and materials, as appropriate for audience, using digital software.

S1.17 Collate information and data into digital engineering software.

1.1 Preparation for the task

Skill content	Knowledge
S1.2 Identify information and data requirements. S1.5 Select data collection and analysis methods. S1.7 Gather relevant information and data – information relevant to the task.	Review of task set to identify the key information and data required to complete the task. (E1, E2, E3, E4, E5) Key considerations for design preparations: • requirements and constraints, and their impact on the initial project brief and design process, for combinations of rural, urban, greenfield and brownfield settings • 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 ○ 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. (K5.1) ○ portal frames – structural steel, timber, concrete. (K5.1) ○ 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 ○ bridges – beam, arch, truss, suspension, cable-stayed, cantilever ○ railway track engineering – methods for earthwork construction in a rail context • client requirements for the project outcomes – building use, to include domestic, industrial, commercial, retail, health, cultural and recreation • surveying of construction projects, to provide relevant information and data requirements to support the design solution. Risk assessments for projects or part of a project on review of scenario: (K1.1, K3.1) • identification of hazards • control measures • pre-survey: (K3.1, K4.1) ○ data and information from pre-survey ○ geological survey – bore holes, trial pits; groundwater – water table, contamination, ground load bearing, foundations. (K10.1, K10.2)

Skill content	Knowledge
	Select data collection, analysis methods and techniques appropriately for civil engineering tasks. Statistical methods: (K9.4) • select and apply statistical techniques correctly to solve practical construction problems • statistical sampling methods to ensure samples are collected without bias and that results will be reliable • sampling methods, e.g. systematic, stratified, simple random • statistical techniques – processing large groups of data to achieve mean, median, mode and standard deviation, cumulative frequency, quartiles, quartile range, methods of visual presentation. How to capture, process and manage data for a construction task: • types of survey • identification of the correct tools and equipment to be used • permissions required to undertake survey work. • compliance with legislation, i.e. health and safety. Statistical methods: (K9.4, K14.3, K14.4) • Use statistical techniques: ○ processing large groups of data to achieve mean, median, mode and standard deviation, cumulative frequency, quartiles, quartile range ○ methods of visual presentation. • Select and apply statistical techniques correctly to solve practical construction problems. • Use statistical sampling methods to ensure samples are collected without bias and that results will be reliable. Research activities: • precedent research • benchmarks • case studies • previous surveys • historical data and information.

1.2 Site investigation requirements of a project

Skill content	Knowledge
S1.6 Inspect the suitability of tools and equipment.	The set-up and use of different tools and equipment to undertake a site investigation for a project: • correct PPE • appropriate surveying equipment in accordance with landowner requirements, including drones (private landowner, Network Rail, Port Authority, Highways Agency, etc.) • appropriate surveying equipment to record measurements: (K11.1, K11.2) ○ lasers ○ Global Positioning System (GPS) ○ digital levels ○ machine guidance ○ automated total stations ○ Global Navigation Satellite System (GNSS) • testing of surveying equipment • uses and advantages of emerging technology in setting out.
S1.8 Use tools and equipment with accuracy. S1.9 Operate safely and apply good housekeeping.	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 • 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: ○ linear – running, offset ○ levelling – height measurement ○ angular – horizontal, vertical height ○ cross checking ○ area (net and gross) ○ volumes ○ height ○ length

Skill content	Knowledge
	• how measurement relates to the design process: ◦ using the correct measurement for its intended purpose ◦ 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 • Civil Engineering Standard Method of Measurement (CESMM) – measurement of quantities • specification of tolerances.

1.3 Planning of civil engineering projects

Skill content	Knowledge
S1.1 Sequence and prioritise individual tasks.	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. (K3, E1, E2, E3, E4, D1, D2, D3, D5) Project and construction risk management: • stages of a construction process: ○ feasibility studies ○ design ○ construction ○ maintenance ○ repair ○ alteration ○ refurbishment ○ contractor procurement ○ commissioning ○ handover • members of the building/construction team involved in project management and their interaction: ○ management at head office or site level ○ technical and professional roles – architect – planner – buyer – estimator – quantity surveyor – civil engineer – structural engineer – resident engineer ○ supervisory roles – contract supervisor – general foreperson – site supervisor ○ general operative roles – labourer – drain layer – steel fixer – plant operative – driver ○ craft roles – joiner – bricklayer – plasterer – electrician – plumber

Skill content	Knowledge
	• planning techniques: ○ resource planning – human, plant and machinery, materials, domestic, nominated subcontractors ○ production of long- and short-term programmes ○ scheduling of material requirements ○ 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) ○ bar charts ○ Gantt diagrams ○ schedules ○ critical path analysis • advantages and disadvantages of resource management techniques, including Building Information Modelling (BIM). • comparison of software systems that can facilitate planning and organisation, and control processes • techniques for value engineering: (K13.4) ○ cost ○ quality ○ time • value engineering: ○ alternative time, labour and materials to determine an economic design ○ cost ○ quality ○ collaborative working risk management • use of Building Information Modelling (BIM) in the collaborative production of construction information; advantages and disadvantages.

Skill content	Knowledge
S1.3 Assess health and safety risks associated with the task.	Conduct risk assessments associated with civil engineering work to reduce health and safety risks. Consider stages of construction to develop suitable risk assessments: (K1.1) • specific risk managements developed for different stages of civil engineering projects, including: ○ 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. (K12.1, K12.1) • statutory constraints and their requirements, including subsequent updates: ○ Health and Safety at Work Act 1974 ○ Construction (Design and Management) Regulations 2015. 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. • 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

Skill content	Knowledge
	• 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
S1.4 Adapt actions to the level of risk.	Review processes to adapt construction methods to reduce the level of risk: (K3.1, E1, E2, E3, E4) • consider further development of risk assessments, including changing design, site or weather conditions • consider statutory constraints and their requirements, including subsequent updates: ○ Health and Safety at Work Act 1974 ○ Construction (Design and Management) Regulations 2015.

1.4 Analysing the client brief and its requirements to develop civil engineering solutions

Skill content	Knowledge
S1.12 Analyse environments against client brief to identify potential issues and problems.	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: (K2, K4, E1, E2, E4, E5, K2.1, K2.2, K4.1, K4.2) ● the need to embed sustainability into solutions: ○ consideration of sustainability in feasibility of projects as a key consideration in the design of projects ○ balancing economic, environmental and social objectives ● the different techniques: ○ energy-based techniques: – reduced energy consumption – improved energy efficiency – use of renewable and alternative sources of energy ○ materials-based techniques: – specification of renewable materials – specification of durable and long-lasting materials requiring minimum maintenance – consideration of embodied energy – low-energy manufacture of materials and components ○ waste-based techniques: – producing less waste and recycling more – off-site prefabrication – modern methods of construction ● brownfield reuse of sites ● inclusive design, including equality and diversity through impact statements; designing to meet Equality Act 2010: ○ accessibility to buildings ○ consideration for people with disabilities ○ car parking design for people with disabilities

Skill content	Knowledge
	• material properties: (K5.1, 5.2, 5.3) ○ types of material, including mass and density: – concrete – glass – timber ○ 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 ○ sources of degradation, including corrosion, chemical degradation and their cause; natural agents ○ 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: ○ concrete and reinforced concrete ○ brickwork ○ timber – external and internal applications ○ steel ○ mortars • effects of temperature changes on construction materials • types of heat: latent, sensible • the effect of temperature change on the properties of materials: ○ changes of state, evaporation, expansion and contraction.

Skill content	Knowledge
S1.15 Produce sketches based on information and data.	Produce sketch diagrams to support civil engineering design solutions, and to demonstrate understanding of civil engineering construction techniques and methods: (E1) • 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 • design production: ○ production of designs for commercial and industrial building design, including foundation details, and the design of beams and columns ○ external works, including retaining walls, drainage, highway construction details, portal frame design and basic bridge design components • communicating information effectively through sketches: ○ clear communication, using technical annotations to ensure correct information is shared and clear understanding of the design is communicated ○ 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.

Skill content	Knowledge
S1.10 Extract relevant information from appropriate sources.	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: (E1, E4, E5) • project information: ○ information used in the production of building designs: (K2.2) – client requirements – site constraints – planning constraints – statutory constraints – environmental constraints – social constraints – economic constraints – sustainability ○ initial project brief – its purpose and content: – spatial requirements – desired project outcomes – site information – budget requirements ○ initial project brief to generate and develop design ideas and specifications.
S1.11 Quality assure the processes used to collect information and data against protocols and standards.	Understand the testing of materials processes and procedures to quality assure the collection of subsequent test data results: (D1, D3) • methods used to test construction materials: ○ concrete test methods – slump, concrete cube ○ timber – stress grading ○ steel – tensile testing ○ soil sampling – trial holes, boring ○ sieve analysis and grading tests ○ chemical composition tests ○ plate compaction tests • statistical sampling methods to ensure samples are collected without bias and that results will be reliable. • sampling methods, including systematic, stratified, simple random.

1.5 Using calculation techniques to support analysis of civil engineering projects

Skill content	Knowledge
S1.13 Carry out calculations related to the scope of work.	Complete mathematical calculations to support design and development and understand how these are used in civil engineering projects: (K9.1, K9.2, K9.3, K9.4) • application of mathematical techniques and formulae to support civil engineering projects: ○ practical construction problems involving perimeters, areas and volumes, including for simple and compound shapes: – rectangles – trapeziums – triangles – prisms – circles – spheres – pyramids – cones – regular and irregular surface areas and volumes ○ use of mensuration formulae and basic calculus in civil engineering (mid-ordinate rule, trapezoidal rule, Simpson's rule) ○ practical construction problems, including surveying, setting out, dimensions of pitched roof and similar: – 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 (K9.2) ○ trigonometric techniques: – sine rule – cosine rule – triangle area rules • understanding the need for accuracy in calculations: ○ techniques and methods – mathematical operations, rounding, decimal places, significant figures, approximation, truncation errors and accuracy

Skill content	Knowledge
	- analysis of structural elements, including beams, walls, struts, ties, frames and columns (K6.1, K6.2, K6.3); effect of different loading conditions and failure under load to enable design of structural elements (K8.1, K5.1) - relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams (K7.1, 7.2, 7.3) - 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 - coplanar forces; Hooke's law; loading, shear forces and bending moments of beams. Solve structural mechanics problems: (K5.1, K8.2, K8.3, K8.4, K8.5, K8.6) - problems relating to beams, columns, frames - 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 - columns – different loading conditions, point loads, axially loaded, eccentrically loaded, effective length, maximum stress - frameworks – different loading conditions, point loads, statically determinate, pin-jointed, subject to dead loads and wind loads.

Skill content	Knowledge
S1.14 Use appropriate techniques to check accuracy of analysis. S1.17 Collate information and data into digital engineering software. S1.16 Model analysed information and data, including geotechnical, structural and materials, as appropriate for audience, using digital software.	Use and application of procedures to check the accuracy of the civil engineering solutions obtained: (D1) (D3) • computer software to analyse and verify manual solutions are correct • predictive models • application of the principles of moments and the laws of static equilibrium. Application of mathematical techniques of approximation and estimations to check accuracy. Application and use of digital software to support and confirm design solutions developed: (K14.1, 14.2, 14.3) • design of retaining walls to relevant factors of safety • shear force and bending moments diagrams • cut-and-fill solutions • use of digital presentation, image handling and desktop publishing. (K14.4)

Performance Outcome 2: Design civil engineering solutions

Knowledge specific to Performance Outcome 2

The analysis of project information for civil engineering solutions requires underpinning knowledge in the following areas:

- K4** Design – new content
- K5** Material properties
- K6** Structural elements, loading and potential failure
- K7** Maths for structural analysis
- K8** Structural mechanics
- K9** Mathematical techniques
- K10** Geology/substructure beyond the core
- K11** Setting out
- K12** Earthworks
- K13** Measurements
- K14** Digital technology

Skills for Performance Outcome 2

The skills will draw on underpinning knowledge appropriate to the context of the scenario. Please refer to the *Occupational Specialism Civil Engineering – Specimen Assessment Material (SAM)* for an example of how underpinning knowledge can be drawn on to meet skills for Performance Outcome 2.

- S2.1** Extract relevant information and data, e.g. geotechnical, structural, visual materials, from a range of secondary sources.
- S2.2** Quality assure provided data, e.g. in terms of accuracy, currency, authenticity, validity and reliability.
- S2.3** Conduct precedent research into potential solutions to a problem, including best practice, benchmarks and design guides.
- S2.4** Think creatively, adapting to challenges arising from requirements.
- S2.5** Assess commercial risk related to potential solutions.
- S2.6** Apply mathematical principles to the scope of work.
- S2.7** Resolve technical issues in the design.
- S2.8** Select methods to present information, e.g. software and drawing techniques.
- S2.9** Determine performance of materials.
- S2.10** Use appropriate techniques to confirm validity of calculations, e.g. case studies, historic records.
- S2.11** Model information, using appropriate digital software and other tools.
- S2.12** Use appropriate techniques to check accuracy of measurements, including scale and proportion, e.g. Ground Validation Points (GVP), known measurements.
- S2.13** Draw on a range of media to communicate a design proposal.

2.1 Initial design considerations

Skill content	Knowledge
S2.1 Extract relevant information and data.	Design preparation requirements: (K4, E1, E2, E3, E4, D4) • preparation of design briefs • consideration of work stages • schedules • specifications • recommendations • programmes. • Extract key information and data required to complete civil engineering problems: ○ types of data and information: – geotechnical – bore holes, trial pits; groundwater – water table, contamination, ground load bearing – structural – visual – materials for secondary sources ○ client requirements for the project outcomes. • Extract key data to design structural components: ○ consideration of solutions for structural elements, loading issues and potential failure in design ○ structural elements, including effect of different loading conditions and modes of failure: (K6.2, 6.3) – beam – column – retaining wall – framework design problems – studs, ties, struts. • Extract relevant information to consider the appropriateness of materials to be used in civil engineering projects: ○ use of special paints, protective coatings; use of sulphate resisting cement (SRC); importance of water/cement ratio ○ materials: structural steel, masonry, timber, reinforced concrete, glass, bricks.

Skill content	Knowledge
S2.3 Conduct precedent research into potential solutions to a problem.	Undertake precedent research to solve civil engineering project problems: (M1, M2, E1, E2, E3) • best practice • benchmarks • design guides • case study research of forms of construction, including methods of excavation, types of foundation, structural forms, retaining walls, drainage, highway design, earthworks, etc. • valuation benchmarking and how this is used to verify delivery of the built environment • technical audits to confirm design and outputs • comparison with similar projects.
S2.5 Assess commercial risk related to potential solutions.	Analyse civil engineering projects to assess the commercial risk. (M5) (D4) Consideration of feasibility of projects and a key consideration in the design of projects. • Design and specification of construction projects: ○ reduction in energy usage ○ minimisation of pollution ○ reduction in embedded energy ○ specification of environmentally friendly/renewable materials ○ reuse of existing buildings and sites. • Project management considerations: ○ simple environmental impact assessments (EIAs) (K4.1) ○ improved management of construction sites ○ clear policies and objectives: – reduction in wastage – increase in recycling – noise management – dust and dirt control – light pollution ○ sharing of good practice ○ raising awareness; communication of information.

Skill content	Knowledge
	• 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. • 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: – 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).

2.2 Site survey requirements of a project

Skill content	Knowledge
S2.12 Use appropriate techniques to check accuracy of measurements.	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: (K11.2) ○ 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 ○ 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) ○ volume ○ height ○ length.

Skill content	Knowledge
	• How measurement relates to the design process: (K4.7) ○ use of methods to predict estimated costs of future projects ○ use of correct measurement for its intended purpose. • Measurement standards, guidance and practice: (K13.1) ○ identification of types of measurement error – systematic, cumulative errors ○ evaluation of the advantages of using different types of surveying equipment in reducing measurement errors (K13.2, 13.3) ○ Civil Engineering Standard Method of Measurement (CESMM) – measurement of quantities ○ specification of tolerances ○ valuations. (K15.1, K15.2)
S2.2 Quality assure provided data, in terms of accuracy, currency, authenticity, validity and reliability.	Understand material testing procedures in order to meet design requirements. Ensure sampled materials are collected without bias or affecting the reliability of test results. • Methods used to test materials: ○ concrete test methods – slump, concrete cube ○ timber – stress grading ○ steel – tensile testing ○ soil sampling – trial holes, boring ○ sieve analysis and grading tests ○ chemical composition tests ○ plate compaction tests. • Statistical sampling methods to ensure samples are collected without bias and that results will be reliable. • Sampling methods, including systematic, stratified, simple random.

2.3 Civil engineering design option considerations

Skill content	Knowledge
S2.8 Select methods to present information – software and drawing techniques.	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: (K14.1, 14.2, 14.3) ○ 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 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: ○ 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 (K14.2) ○ digital data – spreadsheets and schedules ○ digital presentations, PowerPoint, image handling and desktop publishing – brochures and reports. (K14.3, K14.4) The level of detail needed in designs: (K4, E4) • design production: ○ production of designs for commercial and industrial building design, including foundation details and the design of beams and columns ○ external works, including retaining walls and embankments/cuttings ○ infrastructure: drainage, including separate and combined systems, SUDs design, culverts, types of manhole (concrete or brick)

Skill content	Knowledge
	○ highway construction forms (flexible, rigid, composite forms of construction), including footpath details and drainage requirements ○ portal frame design ○ basic bridge design components, including abutments, foundation design ○ consideration of port infrastructure, including access roads, portal frame construction of sheds, concrete pier decking ○ 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 ● importance and ways of communicating effectively. ● clear communication using technical annotations to ensure correct information is shared and clear understanding of the design is communicated. ● techniques used to produce accurate construction drawings: (E4) ● conventions used in survey drawings – appropriate scales for survey drawings ● production of survey drawings to incorporate: ○ level survey plan ○ plotting linear survey lines accurately to scale ○ spot levels ○ grid levels ○ contours ○ site cross section ○ long section detail ○ cut-and-fill cross section ● Application of corrected traverse station coordinates to plot a closed traverse.

Skill content	Knowledge
S2.4 Think creatively, adapting to challenges arising from requirements.	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 ○ 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 ○ portal frames – structural steel, timber, concrete ○ 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 ○ bridges – beam, arch, truss, suspension, cable-stayed, cantilever ○ 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). • Design appropriate structural components to take into account ground conditions present.

2.4 Selection of techniques and materials for a civil engineering project

Skill content	Knowledge
S2.7 Resolve technical issues in the design.	Identify and resolve technical issues in the design of civil engineering design projects. Technical issues in design preparations: • meeting requirements and constraints • change of client requirements in relation to project outcomes, structure use and form, external works • potential remodelling • future extension potential to meet residential needs and business expansion • external and internal aesthetics • technical issues • issues with the types and use of materials • need for sustainability • need for energy efficiency • using alternative types of energy source • schedule issues • specification issues • statutory considerations • implications of statutory obligations to design: (K4.5) ○ statutory constraints and their requirements, including subsequent updates: – Construction (Design and Management) Regulations 2015 – 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) – safety schemes in procurement (SSIP) – 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 ○ environmental constraints: – avoidance of air, water and noise pollution – the findings of Environmental Impact Assessments (EIAs) and their use in developing designs for a project ○ importance of specifications to design guides: (K4.6) – ensuring designs are safe – following best practice – producing economical designs – producing sustainable designs

Skill content	Knowledge
	○ how specifications relate to legislation: (K4.7) – compliance with Health and Safety at Work Act (HASAWA) 1974 – compliance with Construction (Design and Management) Regulations 2015 – compliance with British standards and approved codes of practice. ● social constraints: ○ neighbours' rights ○ local community objections ○ green space requirements ○ environmental requirements ○ mixed and balanced development ● utility diversion: ○ compliance with drainage and other services; building and design requirements.
S2.9 Determine performance of materials.	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. (E1, E2, E3) Understand the properties of materials: (K5.2) ● strength: ○ tensile ○ compressive ○ shear ○ hardness ○ toughness ● mass and density ● bending stiffness ● fatigue and creep ● embedded energy ● recyclability. Understand the degradation of construction materials: ● 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

Skill content	Knowledge
	• sources of degradation and their causes: ○ natural agents – ageing, ultraviolet (UV) radiation timber infestation – insect attack, fungal ○ timber decay – wet rot, dry rot, lichens and mosses ○ moisture movement – capillary action, shrinkage ○ exposure conditions – weathering, freeze-thaw, thermal ageing, creep, humidity, loadings ○ chemical degradation – acid rain, sulphate, alkalis, leaching ○ corrosion in metals – oxidation. • use of special paints and protective coatings; use of sulphate resisting cement (SRC); importance of water/cement ratio • material failure: ○ concrete and reinforced concrete ○ brickwork ○ timber – external and internal applications ○ steel ○ mortars • effects of temperature changes on construction materials • types of heat: latent, sensible ○ effect of temperature change on the properties of materials: changes of state, evaporation, expansion and contraction ○ behaviour of structural elements under load: beams, columns, frameworks. (K8.3)
S2.11 Model information, using appropriate digital software and other tools.	Use digital software to model civil engineering design solutions: (D1, D2, D3) • assessment of the use of BIM in the production of accurate structural design information and the collaborative environment of structural design • use of CAD (Revit) or equivalent software to present solutions in 2D and 3D format • sketching/drawing.
S2.13 Draw on a range of media to communicate a design proposal.	• 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. (E2, E2, E3, D3)

2.5 Use of calculation techniques to support design of civil engineering projects

Skill content	Knowledge
S2.6 Apply mathematical principles to the scope of work.	Complete mathematical calculations to support the design and development of civil engineering projects: (K9.5, K9.6, K9.7, K9.8) • application of mathematical techniques and formulae to support civil engineering projects: ○ practical construction problems involving perimeters, areas and volumes, including for simple and compound shapes: – rectangles – trapeziums – triangles – prisms – circles – spheres – pyramids – cones – regular and irregular surface areas and volumes ○ mensuration formulae and numerical integration methods (mid-ordinate rule, trapezoidal rule, Simpson's rule) ○ practical construction problems, including surveying, setting out, dimensions of pitched roof and similar: (K11.2) – 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 ○ trigonometric techniques: – sine rule – cosine rule – triangle area rules • understanding the need for accuracy in calculations • 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 (K14.4) • practical construction problems – use of graphs to solve construction problems; use of statistics to present data and make decisions based on statistical data

Skill content	Knowledge
	- relationship between force (load), mass and acceleration; coplanar forces; Hooke's law; loading, shear forces and bending moments of beams (K7.2, K7.1) - 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.
S2.10 Use appropriate techniques to confirm validity of calculations. S2.11 Model information, using appropriate digital software and other tools.	- 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

Knowledge specific to Performance Outcome 3

The analysis of project information for civil engineering solutions requires underpinning knowledge in the following areas:

- K5** Material properties
- K6** Structural elements, loading and potential failure
- K7** Maths for structural analysis
- K8** Structural mechanics
- K9** Mathematical techniques
- K10** Geology/substructure beyond the core
- K11** Setting out
- K12** Earthworks
- K13** Measurements – new content
- K15** Valuations

Skills for Performance Outcome 3

The skills will draw on underpinning knowledge appropriate to the context of the scenario. Please refer to the *Occupational Specialism Civil Engineering – Specimen Assessment Material (SAM)* for an example of how underpinning knowledge can be drawn on to meet skills for Performance Outcome 3.

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

3.1 Development of final design solutions for civil engineering projects

Skill content	Knowledge
S3.1 Extract relevant information from provided sources.	Justify how extracted relevant information from a civil engineering project has been applied to develop design solutions: • verify how structural elements, materials, beams, columns, frameworks and retaining walls behave under load • analyse structural elements under load to enable verification of structural elements • assess impact of chosen materials on structural elements: structural steel, masonry, timber, reinforced concrete.
S3.2 Process geotechnical, structural, behavioural and human factors information, and data related to the performance of a proposed solution.	Justify proposed civil engineering solutions in terms of geotechnical and structural behaviour, human factors information and data: (D1, D2, D3, D5, K10.3, K12.3) • geotechnical survey information, bore holes, trial pits; groundwater – water table, contamination, ground load bearing capacity, soil type; settlement and subsidence, soil shrinkage • earthwork design, excavation, cuttings, embankments, earth moving equipment and concreting equipment • information related to the behaviour of structural elements: ○ beams in bending and shear ○ stresses and deflection ○ foundations ○ columns and struts under direct load and eccentric load ○ effect of restraint on members in compression ○ retaining walls in relation to overturning, sliding and overstressing • resource planning • labour management techniques (work and method study; control and organisation of labour) • plant management (hire, lease or purchase; utilisation and control) • factors considered during the planning process that can have an impact on the planning outcomes: ○ labour factors: – availability and cost – skill levels – motivation – productivity

Skill content	Knowledge
	○ 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.
S3.3 Interpret information and data, including from visual and other sources.	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: (E1, E2, E3, D1, D3, K5.3, K8.5) ● consideration of structural elements, loading and potential failure in analysis, design and verification ● use of special paints and protective coatings; use of sulphate resisting cement (SRC); importance of water/cement ratio ● materials – structural steel, masonry, timber, reinforced concrete ● loading, including point, uniform and wind loading ● types of failure – tension, compression, shear ● beams – point of contraflexure consideration; use and application of the bending theory equation; limit state design ● columns – safe axial design load, including allowance for eccentric loaded columns; limit state design ● retaining wall: factors of safety against sliding, overturning and overstressing; middle third rule ● frames: forces in members and if they are struts or ties.

Skill content	Knowledge
	Relationship between force (load), mass and acceleration: - 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 - coplanar forces; Hooke's law; loading, shear forces and bending moments of beams. Rules of measurement and contractual implications (CESMM): (K13.5) - financial implications of works not being priced correctly - 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 - 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 - inclusion of subcontractor quotations – unit rates, lump sums, pricing attendance and special attendance, addition of overheads and profit - completing PC sums and provisional sums (PS) – inclusion of PS and PC sums: - addition for overheads and profit - addition for attendance and special attendance - inclusion of contingency sums - pricing dayworks – labour, materials, plant - 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 - use of computer software to verify manual solutions are correct - types of measurement for the combination of data, cross checking and valuations (K15.1, K15.2) - value engineering techniques. (K13.4)

3.2 Application of professional techniques in the production of technical reports

Skill content	Knowledge
S3.4 Complete technical reports.	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: (K14.1, K14.2, K14.3) • 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, BS 1192 ○ digital data, e.g. spreadsheets and schedules ○ digital presentations, image handling and desktop publishing, e.g. brochures and reports. (K14.4) 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: (K15.1, K15.2) • 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).

3.3 Use and application of calculation techniques to verify civil engineering solutions

Skill content	Knowledge
S3.7 Apply appropriate mathematical techniques to solve structural mechanics problems, including algebra, statistics, trigonometry, calculus. S3.6 Complete costings analysis.	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. (K9.9, K9.10, K1.11, K9.12) Solve structural mechanics problems - reactive forces, maximum load: (K8.2, K8.5, K8.6) • 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: (K9.9) • 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.

Skill content	Knowledge
	Trigonometric, geometric and standard formulae, including circular and triangular measures: (K9.10) • 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 (K11.3) • trigonometric techniques – sine, cosine, tangent ratios, sine rule, cosine rule, triangle area rules. Elementary calculations and techniques including integration and differentiation: (K9.11) • 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.

Skill content	Knowledge
	Statistical methods including averages, tendency and dispersion: (K9.12) • 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.
S3.5 Use digital engineering software with accuracy.	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. (D1, D2, D3) Digital design tools: • 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 ○ digital specification tools - the NBS, BS 1192 ○ digital data – spreadsheets and schedules ○ digital presentations, image handling and desktop publishing – brochures and reports. (K14.4)

Scheme of Assessment – Civil Engineering

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* consists of four Occupational Specialist Components:

1. Surveying and Design for Construction and the Built Environment
- 2. Civil Engineering**
3. Building Services Design
4. Hazardous Materials Analysis and Surveying.

Students will be able to take one of the Occupational Specialist Components as part of their *T Level Technical Qualification in Design, Surveying and Planning for Construction*.

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: Civil Engineering
Externally set project: 25 hours 100% of the Occupational Specialist Component assessment 180 marks Graded P, M and D
Content overview Students are required to: • analyse civil engineering solutions • design civil engineering solutions • verify delivery of civil engineering solutions.
Assessment overview 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:

Task 1: Project analysis

Students will produce an analysis of the proposed project, considering potential risks and commercial viability, and performing calculations to support their report.

Task 2: Report on structural detail

Students will produce a report that explores the choice of structural form for the proposed building works and support this with sketch details.

Task 3: Column and beam design with related mathematics

Students will produce designs for beams and columns showing calculations and structural mechanics diagrams. Students will perform calculations that relate to their design.

Task 4: Design an external works component of the project including CAD drawing details

Students will produce draft designs showing their calculations and CAD design. They will then refine their designs using software.

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.

Timings and scheduling

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

In this assessment, students will:

Civil Engineering		
Performance Outcome	Descriptor	Weightings
1	Analyse civil engineering solutions	39%
2	Design civil engineering solutions	39%
3	Verify delivery of civil engineering solutions	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.

7. Occupational Specialist Component: Building Services Design

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.

Performance Outcome	Key content areas	Skills
1. Analyse building services solutions	K1 Health and safety K1.1 Key requirements, roles and responsibilities associated with health and safety legislation K1.2 Legal health and safety obligations of existing installations K2 Sustainability K2.1 Key requirements, roles and responsibilities associated with environmental protection legislation K2.2 Financial incentives K2.3 Environmental performance measures associated with building services systems K2.4 Energy efficiency of building services systems K2.5 Types of fuel, including storage K3 Scientific concepts and principles and their application to building services systems K3.1 International System of Units (SI), including base units for length, mass, time, electrical current, temperature, amount of substance, luminous intensity K3.2 Derived SI units, including those associated with area, volume, weight, energy and force	S1.1 Analyse information to determine requirements of the task. S1.2 Gather required information. S1.3 Sequence and prioritise individual tasks. S1.4 Interpret information and data, including from visual and other sources. S1.5 Process data, using appropriate techniques. S1.6 Analyse and convey data, using appropriate techniques. S1.7 Calculate data required for design.

Performance Outcome	Key content areas	Skills
	K3.3 Gas laws, including Charles's law, Boyle's law K3.4 Electrical systems and properties, including current, magnetic flux, density, frequency, resistance, voltage, Ohm's law, power, acceleration 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 K3.6 Strength, including tensile, compressive, shear K3.7 Thermodynamics, including laws, material science, phase transition 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 K3.9 Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft K4 Building structures K4.1 Purposes, importance and types of flues and chimneys	

Performance Outcome	Key content areas	Skills
	K5 Principles of building services engineering systems 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 K5.2 Types of control system, their purposes, components, similarities and differences K5.3 Monitoring systems (digital, analogue) and how they collect and transmit data K6 Sources of information, their content and purpose K6.1 Visuals	
2. Design building services	K1 Health and safety K1.3 CDM responsibilities K1.4 Legal and health and safety implications of proposed designs for existing designs K2 Sustainability* K2.4 Energy efficiency of building services systems K2.5 Types of fuel, including storage	S2.1 Explore requirements of the task, using open questioning and listening. S2.2 Use appropriate data and information. S2.3 Conduct precedent research, including best practice, benchmarks and design guides.

Performance Outcome	Key content areas	Skills
	K3 Scientific concepts and principles and their application to building services systems* K3.1 International System of Units (SI), including base units for length, mass, time, electrical current, temperature, amount of substance, luminous intensity K3.2 Derived SI units, including those associated with area, volume, weight, energy and force K3.3 Gas laws, including Charles's law, Boyle's law K3.4 Electrical systems and properties, including current, magnetic flux, density, frequency, resistance, voltage, Ohm's law, power, acceleration 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 K3.6 Strength, including tensile, compressive, shear K3.7 Thermodynamics, including laws, material science, phase transition 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	S2.4 Quality assure provided data. S2.5 Plan logistics, including life cycle, costing, maintenance and installation. S2.6 Apply appropriate mathematical techniques in a construction context. S2.7 Model design, using digital software and other tools. S2.8 Present appropriate design information and data, using different methods and formats. S2.9 Enter data into digital engineering software. S2.10 Provide creative solutions to challenges arising from requirements. S2.11 Adapt design proposals in response to design constraints and stakeholder feedback in terms of time, cost and material factors.

Performance Outcome	Key content areas	Skills
	K3.9 Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft K4 Building structures* K4.1 Purposes, importance and types of flues and chimneys K5 Principles of building services engineering systems* 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 K5.2 Types of control system, their purposes, components, similarities and differences K5.3 Monitoring systems (digital, analogue) and how they collect and transmit data K6 Sources of information, their content and purpose* K6.1 Visuals K7 Construction and the built environment industry K7.1 Planning permission and building regulations relating to all notifiable works	

Performance Outcome	Key content areas	Skills
	K8 Building technology 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 K8.2 Understanding mechanical, electrical and plumbing components K9 Digital technology K9.1 Specialist software and digital tools K9.2 Digital design tools K9.3 Digital specification tools K9.4 Digital data K9.5 Digital presentations, image handling and desktop publishing K10 Design K10.1 How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes K10.2 The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent K10.3 The implications of statutory obligations to designs K10.4 The use and importance of specifications K10.5 The relevance of measurement in the design process *Please see the knowledge content referred to in Performance Outcome 1. This knowledge is also underpinning knowledge for Performance Outcome 2.	

Performance Outcome	Key content areas	Skills
3. Verify delivery of building services solutions	K2 Sustainability* K2.4 Energy efficiency of building services systems K2.5 Types of fuel, including storage K3 Scientific concepts and principles and their application to building services systems* K3.1 International System of Units (SI), including base units for length, mass, time, electrical current, temperature, amount of substance, luminous intensity K3.2 Derived SI units, including those associated with area, volume, weight, energy and force K3.3 Gas laws, including Charles's law, Boyle's law K3.4 Electrical systems and properties, including current, magnetic flux, density, frequency, resistance, voltage, Ohm's law, power, acceleration 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 K3.6 Strength, including tensile, compressive, shear K3.7 Thermodynamics, including laws, material science, phase transition	S3.1 Collate information and data. S3.2 Verify suitability of information and data from appropriate sources specific to the scope of works. S3.3 Interpret information and data, including from visual and other sources. S3.4 Use software with accuracy to verify specific items, utilising appropriate tools. S3.5 Complete costings analysis through, for example, spreadsheet software. S3.6 Present information, using oral and written communication.

Performance Outcome	Key content areas	Skills
	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 K3.9 Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft K4 Building structures* K4.1 Purposes, importance and types of flues and chimneys K5 Principles of building services engineering systems* K5.1 Types of system, their purposes, similarities and differences in operation K5.1 Mechanical components, their characteristics, function within the system and implications for the system of component failure K5.1 Electrotechnical components, their characteristics, function within the system and implications for the system of component failure K5.2 Types of control system, their purposes, components, similarities and differences K5.3 Monitoring systems (digital, analogue) and how they collect and transmit data	

Performance Outcome	Key content areas	Skills
	K6 Sources of information, their content and purpose* K6.1 Visuals K8 Building technology** K8.3 Suitability and operation of performance measurement equipment K8.4 Surveying techniques K11 Valuations K11.1 Industry valuation standards, guidance and practice, and how these are used to verify delivery of the built environment K11.2 Valuation benchmarking and how this is used to verify delivery of the built environment K12 Measurements K12.1 Types of measurement for the combined data K12.2 Techniques for value engineering K12.3 Rules of measurement and contractual implications *Please see the knowledge content referred to in Performance Outcome 1. **Please see the knowledge content referred to in Performance Outcome 2. This knowledge is also underpinning knowledge for Performance Outcome 3.	

Detailed content

The detailed content for each Performance Outcome represents the different activities and associated skills performed when designing building services. Each skill has underpinning knowledge to support skill application.

Performance Outcome 1: Analyse building services solutions

1. Analysis of project information and calculations

Knowledge specific to Performance Outcome 1

The analysis of project information to achieve building services solutions requires underpinning knowledge in the following areas:

K1 Health and safety

K2 Sustainability

K3 Scientific concepts and principles and their application to building services systems

K4 Building structures

K5 Principles of building services engineering systems

K6 Sources of information, their content and purpose

Skills for Performance Outcome 1

The skills will draw on underpinning knowledge appropriate to the context of the scenario. Please refer to *the Occupational Specialism Building Services Design – Specimen Assessment Material (SAM)* for an example of how underpinning knowledge can be drawn on to meet skills for Performance Outcome 1.

S1.1 Analyse information to determine requirements of the task.

S1.2 Gather required information.

S1.3 Sequence and prioritise individual tasks.

S1.4 Interpret information and data, including from visual and other sources.

S1.5 Process data, using appropriate techniques.

S1.6 Analyse and convey data, using appropriate techniques.

S1.7 Calculate data required for design.

Skill content

Analyse information to determine requirements of the task. (S1.1, E5)

- Analysis of a range of information, including:
 - plans
 - 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:
 - test data
 - charts
 - tables
 - drawings to understand existing performance or design requirements.

Gather required information. (S1.2)

- 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.
- Understand and comply with relevant health and safety requirements when undertaking surveys.

Sequence and prioritise individual tasks. (S1.3)

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)**

- resource planning
- bar charts
- Gantt diagrams
- critical path analysis
- use of BIM.

Skill content

Process data, using appropriate techniques. (S1.5)

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.

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

- ways of classifying data and information
- ways that data can be presented.

Calculate, analyse and convey data, using appropriate techniques, in respect of the current provisions/services. (S1.4, S1.6, S1.7)

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
- digital forms of presentation – podcasts, PowerPoint digital brochures, CAD drawings.

Underpinning knowledge

(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.)

K1 Health and safety

K1.1 Key requirements, roles and responsibilities associated with health and safety legislation, and

K1.2 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:*
 - *duties of employers, employees*
 - *the Health and Safety Executive (HSE) and others*
 - *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
- 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:
 - identifying harmful substances
 - assessing risks of exposure
 - types of exposure
 - safety data sheets
 - using/checking/maintaining control measures/equipment
 - training/instruction/information.

Name	Symbol	Quantity	In other SI units
Radian	rad	plane angle	
Hertz	Hz	frequency	
Newton	N	force, weight	
Pascal	Pa	pressure, stress	N/m^2
Joule	J	energy, work, heat	$\text{N}\cdot\text{m} = \text{Pa}\cdot\text{m}^3$
Watt	W	power, radiant flux	J/s
Coulomb	C	electric charge or quantity of electricity	
Volt	V	voltage (electrical potential), emf	W/A
Farad	F	capacitance	C/V
Ohm	Ω	resistance, impedance, reactance	V/A
Weber	Wb	magnetic flux	$\text{V}\cdot\text{s}$
Tesla	T	magnetic flux density	Wb/m^2
Henry	H	inductance	Wb/A
degree Celsius	$^{\circ}\text{C}$	temperature relative to 273.15 K	
Lumen	lm	luminous flux	$\text{cd}\cdot\text{sr}$
Lux	lx	illuminance	lm/m^2
seconds	s	time	
kilograms	kg	mass	
metres	m	length	

K2 Sustainability

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.

K2.1 Key requirements, roles and responsibilities associated with environmental protection legislation

- Environmental Protection Act 1990:
 - waste management, waste transporting, hazardous waste, recycling and safe disposal
 - emissions, reduction through alternative energy, high- and low- embodied materials.
- Environmental Act 1995:
 - enforcement via the Environment Agency
 - other enforcement bodies.
- Water Resources Act 1991:
 - the protection of underground, rivers and coastal water from pollution.

K2.2 Financial incentives

- Taxes and how they may reduce carbon footprint:
 - climate change levy
 - CRC Energy Efficiency Scheme
 - emission trading
 - capital allowance on energy-efficient items
 - landfill tax
 - aggregates levy.
- Life cycle costing:
 - technology solutions
 - selection of sustainable materials and components
 - maintenance requirements
 - running costs
 - demolition and recycling.

K2.3 Environmental performance measures associated with building services systems

- Use of Building Research Establishment Environmental Assessment Method (BREEAM) and the assessment process – sustainability assessment method for planning projects, infrastructure and buildings.
- Categories:
 - management
 - energy
 - health and wellbeing
 - innovation
 - land use and ecology
 - materials
 - transport
 - pollution
 - waste
 - water.

Name	Symbol	Quantity	In other SI units
Radian	rad	plane angle	
Hertz	Hz	frequency	
Newton	N	force, weight	
Pascal	Pa	pressure, stress	N/m ²
Joule	J	energy, work, heat	N·m = Pa·m ³
Watt	W	power, radiant flux	J/s
Coulomb	C	electric charge or quantity of electricity	
Volt	V	voltage (electrical potential), emf	W/A
Farad	F	capacitance	C/V
Ohm	Ω	resistance, impedance, reactance	V/A
Weber	Wb	magnetic flux	V·s
Tesla	T	magnetic flux density	Wb/m ²
Henry	H	inductance	Wb/A
degree Celsius	°C	temperature relative to 273.15 K	
Lumen	lm	luminous flux	cd·sr
Lux	lx	illuminance	lm/m ²
seconds	s	time	
kilograms	kg	mass	
metres	m	length	

K3.2 Derived SI units, including those associated with area, volume, weight, energy and force

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

SI Derived unit	Symbol	Quantity	Symbol
square metre	m^2	area	A
cubic metre	m^3	volume	V
metre per second	$\text{m}\cdot\text{s}^{-1}$	speed, velocity	v
metre per second squared	$\text{m}\cdot\text{s}^{-2}$	acceleration	a
reciprocal metre	m^{-1}	wavenumber	$\sigma, \tilde{\nu}$
kilogram per cubic metre	$\text{kg}\cdot\text{m}^{-3}$	density	ρ
kilogram per square metre	$\text{kg}\cdot\text{m}^{-2}$	surface density	ρ_A
cubic metre per kilogram	$\text{m}^3\cdot\text{kg}^{-1}$	specific volume	V
ampere per square metre	$\text{A}\cdot\text{m}^{-2}$	current density	J
candela per square metre	$\text{cd}\cdot\text{m}^{-2}$	luminance	L_v

K3.3 Gas laws, including Charles's law, Boyle's law

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:

- the volume of a sample of a gas being inversely proportional to its pressure
- relationship of pressure to temperature, volume, mass.
- units of pressure, to include Pascal (Pa), Newtons per square metre (N/m^2)
- units of temperature, including degrees Celsius (C)
- units of volume, including cubic centimetres (cm^3), cubic metres (m^3), litres (l)
- units of mass, including kilograms (kg)
- application of general gas law, including systems under pressure
- application of characteristic gas equations to solve problems related to building services science
- application of Dalton's law ($P_{\text{total}} = P_1 + P_2 + \dots + P_n$) to solve problems involving multiple pressures.

K3.4 Electrical systems and properties

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

- Basic electrical quantities:
 - charge
 - AC
 - DC
 - current
 - voltage
 - resistance
 - conductance

- reactance
- frequency
- standard symbols and their abbreviations.

Calculations and their use within electrical circuits and installations.

- 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:
 - 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.

- Calculations to determine:
 - magnetic flux
 - flux density
 - induced emf
 - electrostatic field strength for capacitors
 - energy stored in inductor
 - back emf
 - self-inductance
 - 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/cm².
- Current: the flow of electrical energy.
- Electromagnetic field: force associated with electric charge in motion.
- AC circuits:
 - capacitance
 - inductance
 - reactance
 - imaginary impedance
 - mutual inductance.

- 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.
- 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).
- 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).

K3.5 Mechanical properties, systems and units

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

- Mechanical properties:
 - strength (tensile, shear, compressive)
 - hardness
 - toughness
 - ductility
 - malleability
 - elasticity
 - brittleness.
- Systems and units:
 - latent heat
 - capillary action
 - velocity
 - ductility
 - malleability
 - force
 - pressure
 - flow rates
 - dynamic pressure
 - humidity
 - atmospheric pressure
 - conduction
 - convection
 - heat transfer
 - heat losses
 - stack effects.

K3.6 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.)
- Ultimate tensile strength (UTS): the maximum stress a material can withstand before fracture.
- The relationship between stress and strain (load and elongation):
 - $\text{stress} = \text{load} / \text{original cross sectional area}$
 - $\text{strain} = \text{change in length under load} / \text{original length}$.
- The difference between compressive and tensile strength.
- 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
- 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
- lubrication (purposes, regimes).

K3.7 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.

K3.8 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
 - 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:
 - bricks – facings, Class A engineering, Class B engineering, commons
 - concrete – prescribed mixes, design mixes, mixes by ratio of volume, mixes by ratio of weight, screed mixes
 - concrete blocks – aerated, high density, insulated
 - mortar mixes – cement mortar, lime mortar, cement lime mortar, coloured mortar
 - sand – building, sharp, silver
 - plasterboard
 - glass and glass finishes – smart, laminated, tempered, float, clear, obscured
 - insulation materials – fibreglass, expanded polystyrene, Celotex, mineral wool, cellulose
 - straw, polyurethane
 - plastics used for polythene damp-proof membranes (DPM), damp-proof courses (DPC)
 - plastics used for doors and window frames, soffits, bargeboards, fascia, guttering
 - polyvinylchloride (PVC), unplasticised polyvinylchloride (uPVC)
 - timber and manufactured boards – hardwoods, softwoods, plywood, chipboard
 - particle board, medium-density fibreboard (MDF)
 - roofing materials – slate, concrete, pantile, roofing felt, thatch, ridge, lead flashing
 - engineered timber – glulam beams, engineered joists
 - steel – mild, stainless, high strength
 - aluminium alloys.

K3.9 Combustion

Know the type of combustion and factors such as fuel air ratio, efficiency and products of combustion.

- Incomplete combustion.
- Stoichiometric.
- Fuels, solid, liquid, gas.
- Flash point.
- Smouldering.
- Diffusion.
- Rapid.
- Spontaneous.
- Flue draft, ventilation.

K4 Building structures

K4.1 Purpose, importance and types of flues and chimneys

Purpose of flues and chimneys – to vent products of combustion.

- Types of flue/chimney:
 - open
 - closed
 - balanced
 - power.
- The design and materials of flues for different fuels.
- Ventilation requirements.
- Commissioning.
- Regulations that apply to flues.
- Scientific concepts and principles, and their application to building services systems.

K5 Principles of building services engineering systems

K5.1 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.

Understand the purpose of building services engineering systems in buildings and know how systems operate to understand similarities and differences.

Cold water (mains, stored)

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.

- 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 to act 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 CO₂ 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:
 - colour code – 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
 - step-down voltage and current
 - 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 mm² PVC insulated twin and earth
 - 1.5 mm² PVC insulated twin and earth
 - 2.5 mm² PVC insulated twin and earth
 - 6 mm² PVC insulated twin and earth
 - 10 mm² PVC insulated twin and earth
 - 1.5 mm² 3-core and earth
 - 1.5 mm² earth
 - 25 mm² 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.

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 o 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.

K5.2 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.

K5.3 Monitoring systems

- Types of system:
 - digital
 - analogue.
- How they collect and transmit data.

K6 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.

K6.1 The different sources of information – visual forms – to present information and data:

- drawings – BS1192
- charts
- graphs
- diagrams
- information and data sources:
 - manufacturers' – brochures, data sheets, specifications, operating manuals and guides
 - client records – maintenance reports, logs
 - third-party sources – utility companies, planning authority
 - specifications – NBS
 - legislation – Building Regulations, health, safety and welfare, gas and electrical regulations
 - survey data
 - digital applications
 - data resulting from analysis
 - data resulting from design
 - data resulting from commissioning and operation
 - conventions
 - symbols.

Performance Outcome 2: Design building services

There are two key abilities that are needed when designing building services: the ability to communicate with a client and the ability to design different building services.

The building services to be designed include:

- ventilation
- air conditioning/cooling
- plumbing
- drainage
- hot water supply
- cold water supply
- heating
- electrical supply
- lighting
- mechanical services.

1. Communication with the client

Underpinning knowledge

K3 Scientific concepts and principles and their application to building services systems*

K7 Construction and the built environment

K10 Design

*Please refer to the knowledge content in Performance Outcome 1. This knowledge is also underpinning knowledge for Performance Outcome 2.

Skill content

Explore requirements of the task, using open questioning and listening. (S2.1)

- 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.

Use appropriate information and data. (S2.2)

- 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.

Underpinning knowledge

K7 Construction and the built environment industry

K7.1 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
 - combustion appliances and fuel storage systems, covered in Approved Document J
 - conservation of fuel and power, covered in Approved Document L
 - electrical safety, covered in Approved Document P.

K10 Design

K10.1 How designs are prepared, including design briefs, work stages, schedules, specifications, recommendations and programmes

The construction design process.

- Stages and tasks involved in the design process.
- 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:
 - preparation and brief
 - concept design
 - developed design
 - technical design.

Factors that influence the design process.

- Requirements and constraints, and their impact on the initial project brief and design process for combinations of rural, urban, greenfield and brownfield settings:
 - client requirements for the project outcomes
 - building use, including domestic, industrial, commercial, retail, health, cultural and recreation; how the building operates within its defined use
 - the project's spatial requirements – building size, layout, circulation space, number of floors, number and use of rooms
 - flexibility and remodelling potential
 - future extension potential to meet residential needs and business expansion
 - external and internal aesthetics, types and use of materials
 - sustainability, energy efficiency, alternative types of energy source
 - age demographic of building user(s); needs of different building users.

Site information and constraints:

- site features – location, size, configuration, orientation, access, topography
- building services availability
- existing buildings and structures
- existing underground services.

Planning constraints:

- planning consent/approval
- avoidance of air, water and noise pollution
- the findings of Environmental Impact Assessments (EIAs) and their use in developing designs for a project.

Project budget and economic constraints:

- cost planning
- available funds
- life cycle costs.

K10.2 The level of detail needed in designs for different situations, and the importance of detail in communicating the design intent

Initial project brief:

- The initial project brief's purpose and its application.
- Content of an initial project brief:
 - spatial requirements
 - desired project outcomes
 - site information
 - budget requirements
 - preliminary programme.
- Use of an initial project brief to generate and develop design ideas and specifications.
- Completion of an initial project brief.
- Use of appropriate tone and technical language for the target audience to communicate the design intent.

K10.3 The implications of statutory obligations to designs

The definition of statutory obligations and how they apply to:

- planning and building regulations
- health and safety
- environment and pollution
- noise.

K10.4 The use and importance of specifications

The purpose and application of specifications to building services engineering design, construction and operation.

- Prescriptive and performance specifications, and the source of specifications for:
 - materials
 - components
 - design process
 - workmanship.
- Importance of specifications – compliance, detail of design.

K10.5 The relevance of measurement in the design process

How measurements are made, and their importance to building services engineering design:

- selection and use of measuring equipment
- accuracy of measuring equipment
- human error
- effect on the design process and specification of plant and equipment
- effect on the placing and fixing of plant and equipment.

Types of measurement:

- area (net and gross) volume, height and length.

2. Design of building services

Underpinning knowledge

K1 Health and safety – only 1.3 and 1.4

K2 Sustainability – only K2.4 and K2.5*

K3 Scientific concepts and principles, and their application to building services systems*

K4 Building structures*

K5 Principles of building services engineering systems*

K6 Sources of information, their content and purpose*

K7 Construction and the built environment industry

K8 Building technology – covered by K3.8, K5.2 and K5.3*

K9 Digital technology

K10 Design

*Please refer to the knowledge content in Performance Outcome 1. This knowledge is also underpinning knowledge for Performance Outcome 2.

Skills

The skills will draw on underpinning knowledge appropriate to the context of the scenario. Please refer to the *Occupational Specialism Building Services Design – Specimen Assessment Material (SAM)* for an example of how underpinning knowledge can be drawn on to meet skills for Performance Outcome 2.

S2.2 Use appropriate data and information.

S2.3 Conduct precedent research, including best practice, benchmarks and design guides.

S2.4 Quality assure provided data.

S2.5 Plan logistics including life cycle, costing, maintenance and installation.

S2.6 Apply appropriate mathematical techniques in a construction context.

S2.7 Model design, using digital software and other tools.

S2.8 Present appropriate design information and data, using different methods and formats.

S2.9 Enter data into digital engineering software.

S2.10 Provide creative solutions to challenges arising from requirements.

S2.11 Adapt design proposals in response to design constraints and stakeholder feedback in terms of time, cost and material factors.

Skill content

S2.2 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 design meets performance requirements.
- Ensure proposed design is within available budget.

S2.3 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.

S2.4 Quality assure provided data.

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

- observations
- survey information
- test data.

S2.5 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.

S2.6 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.

S2.7 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.

S2.8 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)**

S2.9 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.

S2.10 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)**

S2.11 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.

Underpinning knowledge

K1 Health and safety

K1.3 and K1.4 CDM 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.

K8.2 Understanding mechanical, electrical and plumbing components (refer additionally to K5)

Plumbing*

Types of appliance:

- washbasins
- WCs
- baths
- bidets

- shower valve arrangements
- sinks
- washing machines
- dishwashers
- fridges with water and ice dispensers
- water boilers.

K9 Digital technology

K9.1 Specialist software and digital tools

Specialist software for the design of building services installations: how the software can aid design, and the advantages and disadvantages.

- Software may cover a range of disciplines such as:
 - 3D calculation of thermal conductivity to aid the design of building services in buildings
 - heat-loss calculations
 - heating system design
 - electrical design
 - lighting design.

K9.2 Digital design tools

How design tools can be used to produce different building services layout drawings.

- Principles of building services engineering drawings:
 - attributes of orthographic projections, including:
 - geometry – shape of the component represented as different views, how the component is viewed from various angles, visibility of component features
 - dimensions – size of the component in defined units
 - tolerances – allowable variations for defined dimensions
 - material – what the component is to be made from
 - surface texture – surface quality required, roughness, flatness
 - scale – relative to actual dimensions
 - drawing conventions or other relevant international equivalents, including:
 - standards including BS 8888 and BS 60617 or other relevant international equivalents
 - title block/layout – drawing number(s), projection symbols, scale, units, general
 - tolerances, name of author, date, border, parts referencing
 - views – elevation, plan, end, section, hatching style, auxiliary
 - line types – centre, construction, outline, hidden, leader, dimension
 - common features, including screw threads, springs, splines, repeated items, holes, chamfers, radii
 - circuit diagram symbols and components, including cell/battery, switch, resistor, diode
 - capacitors, transistors, integrated circuits, light-emitting diodes (LED), motors, buzzers
 - lettering – titles, notes, annotations
 - abbreviations – A/F, CHAM, DIA, R, PCD, M.
 - coordinates – absolute, relative, polar
 - drawing template – border, title block with all necessary information
 - layers – names, line types, colours, visibility
 - commands – line, circle, arc, polygon, chamfer, fillet, grid, snap, copy, rotate, erase

- stretch, trim, scale, dimensioning, text, pan, zoom-in, zoom-out, insertion and editing
- commands to produce and erase circuit components and connections
- simple and complex areas, predefined hatch patterns, application to cross-sectioning, component libraries, saving in an appropriate format.

K9.3 Digital specification tools

- 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.
- The National Building Specification (NBS):
 - materials
 - standards
 - workmanship.

K9.4 Digital data

- The use of spreadsheets:
 - presentation of information in tables, charts and graphically
 - extracting information
 - the reordering, sorting and manipulation of data
 - calculations
 - storing data.
- Schedules:
 - extracting information from digital drawings
 - extracting information from spreadsheets
 - presenting information in the form of a list with associated details.

K9.5 Digital presentations, image handling and desktop publishing

- The use of digital software to present information:
 - CAD drawings
 - AutoCAD walkthrough
 - podcasts/screencasts
 - digital reports
 - desktop-published brochures.

Performance Outcome 3: Verify delivery of building services solutions

Knowledge specific to Performance Outcome 3

K2 Sustainability – only K2.4 and K2.5*

K3 Scientific concepts and principles and their application to building services systems*

K4 Building structures*

K5 Principles of building services engineering systems*

K6 Sources of information, their content and purpose*

K8 Building technology**

K11 Valuations

K12 Measurements

*Please refer to the knowledge content in Performance Outcome 1.

**Please refer to the knowledge content in Performance Outcome 2. This knowledge is also underpinning knowledge for Performance Outcome 3.

Skills for Performance Outcome 3

The skills will draw on underpinning knowledge appropriate to the context of the scenario. Please refer to the *Occupational Specialism Building Services Design – Specimen Assessment Material (SAM)* for an example of how underpinning knowledge can be drawn on to meet skills for Performance Outcome 3.

S3.1 Collate information and data.

S3.2 Verify suitability of information and data from appropriate sources specific to the scope of works.

S3.3 Interpret information and data, including from visual and other sources.

S3.4 Use software with accuracy to verify specific items, utilising appropriate tools.

S3.5 Complete costings analysis through, for example, spreadsheet software.

S3.6 Present information, using oral and written communication.

Post-installation activities

Skill content

S3.1 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 date
- certificates
- approval
- health and safety file
- maintenance schedules.

S3.2 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)**

S3.3 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.

S3.4 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.

S3.5 Complete costings analysis.

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)**

S3.6 Present information, using oral and written communication. (E1, E2)

Use digital software to present information:

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

Underpinning knowledge

(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.)

K11.1 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).

K11.2 Valuation benchmarking and how it is used to verify delivery of the built environment

- Technical audits to confirm design and outputs.
- Comparison with similar projects.

K12.1 Types of measurement for the combined data

Understand how to measure building services work for the purpose of producing valuations for accounts. This will include:

- measured work – item, nr, m, m², m³
- provisional and prime cost items
- preliminaries
- lump sums
- dayworks.

K8.3 Suitability and operation of performance measurement equipment

The different types of performance measurement equipment and how they work:

- air quality: indoor air quality meter – water vapour, particulates, allergens, dust, toxic vapours and gases
- noise levels: decibel meter – levels of sound
- light levels: lux meter – luminance intensity.

K8.4 Surveying techniques

Understand the techniques used to carry out measurements and assess pipework and electrical circuits within building services engineering.

- Instruments used to check flow rates and water pressure:
 - pressure gauges for static and kinetic pressure
 - inline meters or volume per second rates for flowrates
 - manometers for gas pressure – analogue and digital.
- Instruments used for checking, verifying and problem-solving within electrical circuits, and how and why they are used.
 - multimeter or separate meters – ohm meter, ammeter, voltmeter
 - PAT testing equipment
 - continuity testing

- non-contact voltage tester
- digital clamp meter
- multifunction tester.

K12.2 Techniques for value engineering

- Business analysis methods:
 - feasibility study methodology and approaches
 - other feasibility and viability methods:
 - PESTEL (political, economic, social, technological, environmental, legal) analysis
 - SWOT (strengths, weaknesses, opportunities, threats) analysis
 - 5 Cs (customer, company, competition, collaborators, context) analysis
 - Porter's Five Forces
 - cost-benefit analysis.
- Residual method of valuation:
 - feasibility factors:
 - changes in floor area, volume, elements price indices and use
 - availability of land, labour and finance
 - client requirements
 - planning and regeneration policy changes
 - legal and environmental requirements
 - specification standards
 - local property market and rental yield
 - client's approach/attitude to sustainability and the impact on the environment.
- Modelling and testing of factors impacting on projects:
 - modelling and testing of current costs, opportunities and constraints
 - modelling and testing of alternative scenarios
 - forecasting and reporting techniques:
 - cost forecasting, including cash flow, profit, return, cost and value
 - liquidity, including borrowing, working capital and profitability
 - use of software packages.

K12.3 Rules of measurement and contractual implications

Standard methods of measurement – the use of the Standard Methods of Measurement (SMM) rules in the production of quantities.

- Measurement rules:
 - the need for rules
 - origins of measurement rules
 - measurement initiative steering group
 - status of the Royal Institution of Chartered Surveyors (RICS) New Rules of Measurement (NRM)
 - status of the Institution of Civil Engineers (ICE) Civil Engineering Standard Method of Measurement (CESMM)
 - typical considerations:
 - units of measurement
 - deduction of voids
 - deemed to be included
 - item description
 - hierarchy of description

- key content
 - preliminaries and measured work
 - guidance on the preparation of bills of quantities.
- The New Rules of Measurement (NRM):
 - NRM 2 – detailed measurement for building works:
 - application to taking off quantities for projects
 - uses of NRM 2
 - NRM 3 – order of cost estimating and cost planning for building maintenance works:
 - application to maintaining projects
 - uses of NRM 3.
- CESMM:
 - content and its application to civil engineering projects
 - differences against the NRM volumes.

Scheme of Assessment – Building Services Design

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* consists of four Occupational Specialist Components:

1. Surveying and Design for Construction and the Built Environment
2. Civil Engineering
- 3. Building Services Design**
4. Hazardous Materials Analysis and Surveying

Students will be able to take one of the Occupational Specialist Components as part of their *T Level Technical Qualification in Design, Surveying and Planning for Construction*.

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
Externally assessed project: 20 hours 40 minutes 100% of the Occupational Specialist Component assessment 180 marks Graded P, M and D
Content overview Students are required to: • analyse building services solutions • design building services solutions • verify delivery of building services solutions. The building services that will be covered for this assessment consist of the following: • ventilation • air conditioning/cooling • drainage • hot water supply • cold water supply • heating • electrical supply • lighting • mechanical services.

Assessment overview

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:

Task 1: 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.

Task 2a: Students complete design calculations related to the required information for the building service at hand.

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.

Timings and scheduling

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

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* 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 Outcomes

In this assessment, students will:

Building services design		
Performance Outcome	Descriptor	Weightings
1	Analyse building services solutions	25%
2	Design building services solutions	55%
3	Verify delivery of building services solutions	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
Task 6b	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.

8. Occupational Specialist Component: Hazardous Materials Analysis and Surveying

Content Summary

The content is separated into four performance outcomes, along with the skills needed to achieve threshold competence and the knowledge to underpin skill application across the following areas.

Performance Outcome	Key content areas	Skills
1. Inspect the built environment	K1 Health and safety K1.1 Public liability laws to consider when inspecting the built environment K1.2 Implications of poor health and safety performance (ethical, legal, financial) K1.3 Risk management K1.4 Safety-conscious behaviours required when inspecting built environments K2 Commercial/business K2.1 Confidentiality K3 Hazardous materials K3.1 How the use and regulation of hazardous materials (including asbestos) have changed over time K3.2 The intended construction purpose of hazardous materials (including asbestos) and where they are likely to have been used in buildings	S1.1 Identify information required to complete the task. S1.2 Sequence and prioritise research tasks. S1.3 Collect information from primary and secondary sources as appropriate, including samples and historic records. S1.4 Extract relevant information from appropriate sources to identify potential for the presence of hazardous materials. S1.5 Process data, including collation and entering into digital software, using appropriate techniques. S1.6 Quality assure collected data. S1.7 Complete required documentation, including method statements and reports, using digital software. S1.8 Assess health and safety risks associated with the environment and task. S1.9 Operate safely in a site environment.

Performance Outcome	Key content areas	Skills
	K3.3 Techniques used to locate and identify hazardous materials, including HSE and UKAS requirements K3.4 Appropriate response to each type of hazardous material, including guidance and mandatory requirements K4 Tools, equipment and materials K4.1 Types of equipment K4.2 Operation of specialist plant, processes and machinery, including safe methods of working K5 Law and regulations K5.1 Permissions required to undertake survey work	S1.10 Use tools and equipment with accuracy. S1.11 Operate safely, applying good housekeeping. S1.12 Apply safe processes to waste disposal. S1.13 Use appropriate techniques to check accuracy of collected data.
2. Identify hazardous materials	K1 Health and safety K1.2 Implications of poor health and safety performance (ethical, legal, financial) while undertaking processes K1.3 Risk management K1.4 Safety-conscious behaviours, including client, duty of care and information management K3 Hazardous materials K3.5 Techniques used to respond to hazardous materials	S2.1 Extract relevant information from appropriate sources. S2.2 Evaluate the suitability of information and data for completing tasks. S2.3 Quality assure information and data from secondary sources. S2.4 Interpret information and data, including from visual and other sources. S2.5 Complete required documentation and reports, using digital software.

Performance Outcome	Key content areas	Skills
	K4 Tools, equipment and materials K4.2 Operation of specialist plant and machinery K4.3 Maintenance of equipment K4.4 Calibration of equipment K4.5 Repair of equipment K6 Survey techniques K6.1 How to collect a variety of samples, including personal, background, reassurance and clearance sampling K6.2 Requirements for communicating information at appropriate times K6.3 How to collect appropriate samples to enable analysis	S2.6 Operate sampling and other equipment. S2.7 Inspect the suitability of materials, tools and equipment. S2.8 Use appropriate techniques to ensure the integrity of samples, including visual inspections of work areas and enclosures risk.
3. Analyse hazardous materials	K1 Health and safety K1.2 Implications of poor health and safety performance (ethical, legal, financial) K1.5 Risk management in the analysis processes K1.6 Safety-conscious behaviours during analysis K4 Tools, equipment and materials K4.1 Types of sampling and measuring of equipment K4.6 Maintenance of analysis equipment K4.7 Calibration of analysis equipment K4.8 Repair of analysis equipment	S3.1 Sequence and prioritise task requirements. S3.2 Analyse samples, using appropriate techniques. S3.3 Convey information, data and outcomes, using appropriate techniques. S3.4 Use chemical preparation, morphology and composition, phase contrast microscopy and fibre counting. S3.5 Apply appropriate mathematical techniques. S3.6 Operate equipment safely. S3.7 Apply safe processes to waste disposal.

Performance Outcome	Key content areas	Skills
	K4.9 Operation of different types of technical equipment K7 Samples analysis K7.1 Techniques using microscopy, including chemical preparation, morphology, composition and phase contact K7.2 Management and disposal of sample materials	S3.8 Manage the confidentiality and security of information and data. S3.9 Select information and data, and present using techniques appropriate to the audience. S3.10 Use appropriate techniques to check accuracy of analysis and predictive models. S3.11 Inspect the suitability of scientific tools and equipment.
4. Monitor hazardous materials	K1 Health and safety K1.2 Implications of poor health and safety performance (ethical, legal, financial) K4 Tools, equipment and materials K4.10 Types of equipment used in monitoring hazardous materials, their characteristics and purpose K4.11 Importance of and how to maintain monitoring equipment, including storage K4.12 Importance of calibration of equipment K4.13 Techniques used in the repair of equipment K4.14 Operation of specialist plant and machinery K8 Monitoring K8.1 Techniques for monitoring hazardous materials, including removal and disposal	S4.1 Verify suitability of information and data from appropriate sources specific to the scope of works. S4.2 Interpret information and data, including from visual and other sources, to identify issues. S4.3 Negotiate requirements with stakeholders. S4.4 Provide information, advice and guidance, using appropriate communication techniques. S4.5 Present technical information for different types of stakeholder.

Performance Outcome	Key content areas	Skills
	K8.2 Safe management of retained hazardous materials K8.3 Advice stakeholders require on monitoring responsibilities K9 Communication K9.1 Methods of conveying and presenting information to stakeholders K9.2 Privacy and confidentiality K9.3 Whistle-blowing and escalating information	

Detailed content

The detailed content for each Performance Outcome represents the different activities and associated skills performed when analysing and surveying hazardous materials. Each skill has underpinning knowledge to support skill application.

Performance Outcome 1: Inspect the built environment

Preparing for the task

Skill content	Knowledge
S1.1 Identify information required to complete the task.	The information needed to complete an inspection of the built environment in order to determine the presence of hazardous materials, including the purpose and use of: • information pertaining to the building (present and historic) • layout plans and specifications for the original building and also for extensions, adaptations and refurbishments • listed building and conservation area status • access requirements • utility services and isolation procedures • information obtained from the client on site –specific hazards • details of previous surveys/existing hazardous material registers. Types of hazardous material found in the built environment: • asbestos: ○ crocidolite (blue asbestos) ○ amosite (brown asbestos) ○ chrysotile (white asbestos) ○ actinolite ○ anthophyllite ○ tremolite • cement • lead • solvents: ○ toluene ○ xylene ○ white spirit ○ acetone ○ ethyl acetate • isocyanates – highly reactive • microorganisms that may cause legionella, anthrax, psittacosis, leptospirosis/Weil's disease, Aspergillus • carbon monoxide, methane – poisonous gases.

Skill content	Knowledge
	The intended construction purpose of hazardous materials: (K3.2) • Asbestos containing cement – the fibres provide strength without adding much weight. Its insulating and fire-resistant properties also made the mineral an ideal substance to add to cement. • Lead was incorporated into soft solder, an alloy of lead and tin, and used for soldering tinsplate and copper pipe joints. Lead-based paint inhibits the rusting and corrosion of iron and steel. The key information and data required for a survey plan for completing an inspection of a built environment for hazardous materials. • Techniques used to locate and identify hazardous materials, including Health and Safety Executive (HSE) and United Kingdom Accreditation Service (UKAS) requirements: (K3.3) ○ visual inspection – visual clues – trade names on materials – dimples on asbestos cement – mica crystals in supalux (material not containing asbestos) – exposed fibre bundles on raw edges – warning labels – material safety data sheets for chemicals – characteristic smells for chemicals (ammonia smells of stale urine etc.) – benchmark against known visuals of hazardous materials – photographs ○ sampling ○ laboratory analysis. • Actions to take when dealing with different types of hazardous material: (K3.4) ○ leave the area and report it ○ encapsulate the substance so the material does not escape ○ minimise the number of workers who could be exposed to the hazard by restricting access to the area and, if necessary, operating a permit to work scheme ○ train workers to operate in the area with the hazardous material ○ provide personal protective equipment ○ prepare and keep up to date a hazardous material register. • The importance of the survey plan, what information should be collected and included in the plan, and the requirement to involve the client in the process. • The necessity for visual inspections. • An appropriate response to each type of hazardous material, including guidance and mandatory requirements.

Skill content	Knowledge
S1.3 Collect information from primary and secondary sources as appropriate, including samples and historic records.	Understand how to capture, process and manage data for a hazardous material inspection. This should cover in detail: • the types of survey, including management • historical data • existing surveys • refurbishment and demolition surveys • the permissions required to undertake survey work, highlighting the key legislative requirements and provisions for compliance with: (K5.1) ○ Regulations 5–15, 17–19 and 22–23 of Control of Asbestos Regulations 2012 ○ Health and Safety at Work etc. Act 1974 ○ Control of Substances Hazardous to Health (COSHH) Regulations 2002, covering the employer’s duties, including provision of: – risk assessment of all substances used in the workplace, highlighting precautionary methods to be employed before and during use – control measures – control exposure to substances hazardous to health, to prevent ill health; using control equipment; managerial controls, including permits to work; encouraging appropriate worker behaviour – use, maintenance, examination and testing – reducing the risk of exposure to an acceptable level – monitoring and health surveillance of employees using substances hazardous to health at work – information, instruction and training of employees ○ Control of Lead at Work Regulations 2002 ○ Dangerous Substances and Explosive Atmospheres Regulations 2002 ○ Hazardous Waste (England and Wales) Regulations (Amendment) 2016. • Use digital software, such as spreadsheet software or word processing software, to capture risk assessments. (D1) • Convey and summarise technical information through risk assessments for stakeholders. (E1, E4) • The primary duties of care (K1.1) that arise under public liability laws when inspecting the building environment for hazardous materials, including the Occupiers’ Liability Act 1957 and 1984; a duty of care on occupiers that all lawful visitors and others are reasonably safe for the purposes for which they are on the occupier’s premises. • The reasons why asbestos was originally used as a material in buildings, covering its physical and chemical properties, different fibre properties and resistances, and insulating and fire-resistant properties.

Skill content	Knowledge
	• How the use and regulation of hazardous materials have changed over time: (K3.1) ○ Health and Safety at Work etc. Act 1974 ○ Control of Substances Hazardous to Health (COSHH) Regulations 2002 ○ lead: voluntary agreement in 1963 with the Paintmakers Association, adding labelling and warning notices to white lead paint; most white lead-based paint was banned apart from specialist uses in 1992 (The Environmental Protection (Controls on Injurious Substances) Regulations 1992); safer forms of red lead paint used since 1992; the Control of Lead at Work Regulations 2002 ○ asbestos: the emergence of asbestosis in the 1900s and an appreciation of the evolution of asbestos legislation, covering: – the Factory and Workshop Act 1901 – Merewether and Price Report 1930 – Asbestos Industry Regulations 1931 – Factories Act 1961 – first successful personal injury claim 1967 – Asbestos Regulations 1969 – Voluntary Asbestos Import Ban 1970 – Health and Safety at Work etc. Act 1974 – Voluntary Asbestos Import Ban 1980 – Asbestos Licensing Regulations 1983 and later amendments – Asbestos Prohibition Regulations 1985 and later amendments – Control of Asbestos at Work Regulations 1987 and later amendments – Control of Asbestos in the Air Regulations 1990 – Asbestos Prohibition Regulations 1992 – Control of Asbestos at Work Regulations 2002 – Control of Asbestos Regulations 2006.

Analysing data to develop an inspection regime, to determine hazardous materials within the built environment

Skill content	Knowledge
S1.4 Extract relevant information from appropriate sources to identify potential for the presence of hazardous materials.	The different types of hazardous material in the built environment: • where hazardous materials are likely to have been used in the built environment: (K3.2) ○ spray coatings ○ cements ○ loose-fill insulation ○ lagging ○ ceiling and floor tiles ○ insulation board ○ rope seals ○ gaskets ○ textiles ○ soffit boards ○ textured decorative coatings ○ roofing felt, gutters and downpipes ○ paper and paper products ○ paints ○ asbestos bitumen products ○ mastics ○ sealants ○ putties and adhesives ○ reinforced plastics ○ domestic appliances ○ plant and machinery ○ asbestos contamination in other products. • exposure routes into the body for hazardous materials: ○ inhalation ○ skin and eyes ○ mouth/ingestion. The effects on the body of hazardous materials, including the difference between acute and chronic conditions and the risk of developing disease: • levels and duration of exposure that cause harm: ○ asbestos ○ cement ○ lead ○ solvents ○ microorganisms that may cause legionella, anthrax, psittacosis, leptospirosis/Weil's disease, Aspergillus ○ carbon monoxide, methane

Skill content	Knowledge
	• acute effect of hazardous materials: ○ dizziness ○ headaches ○ nausea ○ burns ○ coughing and wheezing • chronic effect of hazardous materials: ○ mesothelioma ○ asbestosis ○ pleural thickening ○ leukaemia ○ lung disease ○ lung fibrosis ○ occupational asthma ○ kidney damage.
S1.5 Process data, including collation and entering into digital software, using appropriate techniques.	Use of digital software to support and confirm the agreed survey procedure, covering the principles and use of: • CAD to schedule the location of hazardous materials and plan sampling locations • BIM facilities management packages to virtually twin the building and record location of known materials • spreadsheets to prepare site inspection record sheet templates. Collecting survey data during the survey. The survey procedure will include information such as: • a plan of the agreed number of samples and sampling methods • site photographs • a procedure for making good any intrusive sampling • details of the survey working times on site • any necessary signage • building/site access arrangements for site and workers • the confidentiality requirements of client data, including adhering to data protection legislation. (K2.1)

Skill content	Knowledge
S1.6 Quality assure collected data	The importance of data collection to support the hazardous material on-site survey: • to enable previous building use to be considered when evaluating likely hazardous materials • to facilitate the preparation of risk assessments • to facilitate the preparation of the hazardous material survey. The selection of data from primary and secondary sources in accordance with quality assurance protocols and standards, specifically: • the governing principles for compliance with ISO 9001 quality management systems • the principles of quality assurance and control.
S1.7 Complete required documentation, including method statements and reports, using digital software.	Digitally prepared reports used for inspection of hazardous materials: (D1) • preparation of survey plans and how parameters that need to be assessed during the survey are recorded, including information relating to: (E1, E2) ○ location of the material ○ type of product ○ accessibility implications ○ material condition ○ the presence, or not, of a surface treatment • method statements: convey 'step by step' in a logical sequence how the survey works will be carried out; (E1) present method statement using standard practice (E2) • synthesising information from sources to conduct risk assessments and plan method statements (E4, E5) • hazardous material registers • sample inspection record.
S1.13 Use appropriate techniques to check accuracy of collected data.	The importance of using predictive models, using data and probability to check/forecast accuracy of data collected from samples: • structure activity relationships (SAR) • nearest analogue analysis • chemical class analogy • mechanisms of toxicity • mass balance models and measured data.

Planning an inspection of the built environment

Skill content	Knowledge
S1.2 Sequence and prioritise research tasks.	Identify and understand hazardous material survey techniques that could be adopted in an on-site inspection of the built environment, including the following: • survey procedures: ○ plan agreed number of samples and sampling methods ○ taking in situ photographs of potentially hazardous material ○ procedure for making good after any intrusive sampling ○ survey times of work ○ signage to be used ○ key access route • tools, equipment and materials • types of equipment: ○ sampling ○ measuring • operation of specialist plant, processes and machinery, including safe methods of working • law and regulations.
S1.8 Assess health and safety risks associated with the environment and task.	Understand the risks and hazards associated with on-site inspection of hazardous materials for the built environment, including the need to develop suitable control methods, covering the following: • risk assessments and the requirement, where appropriate, for a written asbestos management plan • using risk assessment templates to summarise and convey technical information to stakeholders (E1, E4) • using digital software such as spreadsheets or word processing software to capture risk assessments electronically (D1) • risk management in occupied space: (K1.3) ○ non-asbestos hazards – working at height (in ceiling voids or on a fragile roof), working on operable machinery or plant, working in confined spaces, chemical hazards, electrical hazards, biological hazards, noise hazards and lone working ○ asbestos issues – preventing disturbance and spread of asbestos-containing materials, safe working procedures for sampling, PPE, decontamination and disposal arrangements, risk management in the analysis processes

Skill content	Knowledge
	• licensable and non-licensable survey work • risk review processes to adapt survey procedure to reduce the level of risk • categories of risk control measures: ○ elimination – removal of risk in its entirety ○ substitution – reduction of risk by making a change to a material, substance or procedure ○ engineering control measures – collective measures for personnel or individual measures ○ administration controls – permit to work schemes and safe working procedures ○ personal protective clothing • people at risk: ○ building users/occupiers ○ visitors ○ public ○ maintenance and construction workers • the implications of poor health and safety performance (ethical, legal, financial) while undertaking the process, covering: (K1.2) ○ the 'health and safety iceberg' ○ increased risk of ill health, injury and death ○ loss of reputation ○ legal repercussions ○ decrease in productivity, increase in turnover.

Undertaking a preliminary site inspection to confirm an inspection regime to determine hazardous materials within the built environment

Skill content	Knowledge
S1.9 Operate safely in a site environment.	Understand the techniques to undertake an on-site inspection of the built environment for hazardous materials, including the following: • appropriate responses to hazardous materials, covering best practice guidance and mandatory requirements • approach to safety-conscious behaviours and culture, covering: (K1.4) ○ the definition of 'safe' and 'unsafe' behaviour ○ observation of behaviour in the workplace by managers and/or peers, with/without targets ○ providing feedback to reinforce safe behaviour and to 're-educate' unsafe behaviour, covering on-the-spot specific feedback and discussion and impersonalised general data ○ requirements for medical examinations and health surveillance ○ welfare provision, such as 'dirty' and 'clean' hygiene facilities ○ safe sample and material controls during sample analysis ○ use of correct PPE.
S1.10 Use tools and equipment with accuracy.	Use surveying tools and equipment with accuracy, understanding how errors in measurement may occur and how they could be reduced: • identification of the correct tools and equipment to be used for sampling and measuring: (K4.1) ○ survey equipment – site plan, logbook, stepladder, camera, torch, access keys to room and covers, screwdrivers ○ PPE – disposable overalls (hooded), overshoes and gloves, respirator with P3 dust filter, respirator with P3 dust filter, masks ○ bulk sampling equipment – pliers, screwdrivers, core samplers or cork borers, aluminium foil or cloth tape, utility knives, hand spray with diluted PVA or surfactant, sample bags (polythene self-seal bags), sample point labels, type H vacuum, approved asbestos waste bags, warning signs, wet wipes and tissues, polythene sheets, air quality measuring equipment, enclosures.

Skill content	Knowledge
	Understand how to collect a variety of samples, including: • systematic survey inspection procedures and timing: ○ internal work upwards from the basement to the roof, working around each area clockwise from the door of entry ○ visually inspecting and reviewing components in the following order: – ceiling – walls – floors – fixtures and fittings – equipment – services • size, location and frequency of samples for different hazardous materials • sampling techniques: ○ enclosures ○ selection of sampling point for different hazardous materials ○ use of water/surfactant sprays ○ shadow vacuuming ○ sampling with different equipment, including core sampler, sharp knife, chisel, pliers, screwdriver ○ retrieval of sample ○ sealing of exposed surface, including tapes and fillers ○ cleaning up debris ○ use of polythene floor covering • selection and use of PPE and RPE, and techniques for decontamination • sample treatment: ○ individually sealed ○ double bagging ○ unique identifier labelling • use of warning signage • types of safety sampling: ○ personal – sample taken from a person's clothing or personal belongings, or blood/fluid sample ○ background – sample of potential contaminant in a work area ○ reassurance – samples that are conducted for confirmation that an area is clear after hazardous material has already been removed.

Skill content	Knowledge
S1.11 Operate safely, applying good housekeeping.	Operate specialist plant, process and machinery in compliance with safe methods of working, covering the following: (K4.2) • assessing health and safety risks • operating safely in a site environment • using tools and equipment with accuracy • following safe systems of work and permit to work schemes • using appropriate PPE and complying with the health and safety regulations in differing built environments • understanding site safety procedures for emergencies, including decontamination. Communicate with others, using technical language, to operate equipment safely. (E1, E3, D3)
S1.12 Apply safe processes to waste disposal.	Follow procedures to transport hazardous waste to a licensed disposal site, in accordance with the requirements of the Hazardous Waste (England and Wales) Regulations 2005, including 2016 amendments: • waste to be sent with a registered carrier to an authorised site • waste to be classified and separated • completion of a consignment note • waste records to be kept for one year.

Performance Outcome 2: Identify hazardous materials

Preparation for on-site sampling

Skill content	Knowledge
S2.1 Extract relevant information from appropriate sources.	Examine building plans, desk studies and preliminary site inspection information, including all features and services, including voids, cavities, risers, ducting and under crofts, to determine the likelihood of the presence of hazardous materials, reviewing the following: • preliminary site inspection information: ○ information pertaining to building (present and historic) ○ layout plans and specifications for the original building and also for extensions, adaptations and refurbishments ○ listed building and conservation area status ○ access requirements ○ utility services and isolation procedures ○ information obtained from the client on site – specific hazards ○ details of previous surveys/existing hazardous material registers • the likely location of hazardous materials, covering: ○ spray coatings ○ cements ○ loose-fill insulation ○ lagging ○ ceiling and floor tiles ○ insulation board ○ rope seals ○ gaskets ○ textiles ○ soffit boards ○ textured decorative coatings ○ roofing felt ○ gutters and downpipes ○ paper and paper products ○ paints ○ asbestos ○ bitumen products ○ mastics ○ sealants ○ putties and adhesives ○ reinforced plastics ○ domestic appliances ○ plant and machinery ○ contamination in other products

Skill content	Knowledge
	• types of hazardous material: ○ asbestos, including the different types – crocidolite (blue asbestos), amosite (brown asbestos), chrysotile (white asbestos) actinolite, anthophyllite, tremolite ○ cement ○ lead ○ solvents ○ isocyanates ○ microorganisms – Legionella, anthrax, psittacosis, leptospirosis/Weil's disease, Aspergillus ○ carbon monoxide • the order of visual inspection: ○ ceiling ○ walls ○ floors ○ fixtures and fittings ○ equipment ○ services.
S2.2 Evaluate the suitability of information and data for completing tasks.	Evaluate building plans, desk studies and preliminary site inspection information to determine the quality and quantity of information required, to enable valid on-site sampling of hazardous materials to be made, justifying any additional information requirements. Sources of information include the following: • information pertaining to building (present and historic) • layout plans and specifications for the original building and for extensions, adaptations and refurbishments • listed building and conservation area status • access requirements • utility services and isolation procedures • information obtained from the client on site-specific hazards • details of previous surveys • existing hazardous material registers.

Skill content	Knowledge
S2.4 Interpret information and data, including from visual and other sources.	Interpret building plans, desk studies, preliminary site inspection information and further authorised studies to plan a systematic survey inspection procedure. The systematic survey should proceed with internal work upwards from the basement to the roof, working around each area, clockwise from the door of entry, reviewing components in the following order: ceiling, walls, floors, fixtures and fittings, equipment and services. The systematic survey inspection should cover the following for different hazardous materials: (E5) • size of sample • location of sample • frequency of sampling. Create texts (E3) to convey and present ideas through detailed survey plans (E1, E2) using digital software. (D1)
S2.3 Quality assure information and data from secondary sources.	Develop a quality assurance procedure for on-site sampling of hazardous materials, including: • reinspection of a proportion of the survey while survey work is still ongoing • audits of completed surveys • third-party check • competency check of survey inspection team.

Undertaking on-site sampling to determine hazardous materials present within the built environment

Skill content	Knowledge
S2.7 Inspect the suitability of materials, tools and equipment.	Inspect the suitability of materials, tools and equipment to complete an on-site hazardous material survey covering the following: • checking for damage • inspection of the suitability of survey equipment: ○ site plan ○ logbook ○ stepladder – standard check with Work at Height Regulations 2005 ○ camera ○ torch ○ access keys to room and covers, screwdrivers • inspection of the suitability of sampling equipment: ○ pliers ○ screwdrivers ○ core samplers or cork borers ○ aluminium foil or cloth tape ○ utility knife ○ hand spray with diluted PVA or surfactant ○ sample bags (polythene self-seal bags) ○ sample point labels ○ type H vacuum ○ approved asbestos waste bags ○ warning signs ○ wet wipes and tissues ○ polythene sheets • inspection of the suitability of personal protective equipment, including RPE, disposable overalls (hooded), overshoes and gloves • a visual condition check prior to use.
S2.6 Operate sampling and other equipment.	Collect a variety of samples, including personal, background, reassurance and clearance samples, (K6.1) covering the following: • safety-conscious behaviours, including client, duty of care and information management, (K1.2) in accordance with health and safety regulations and best practice

Skill content	Knowledge
	• risk management in occupied spaces: (K1.3) ○ non-asbestos hazards – working at height (in ceiling voids or on a fragile roof), working on operable machinery or plant, working in confined spaces, chemical hazards, electrical hazards, biological hazards, noise hazards and lone working ○ asbestos issues – preventing disturbance and spread of asbestos-containing materials, safe working procedures for sampling, PPE, decontamination and disposal arrangements, risk management in analysis processes • implications of poor health and safety performance (ethical, legal, financial) while undertaking processes: (K1.2) ○ the ‘health and safety iceberg’ ○ increased risk of ill health, injury and death ○ loss of reputation ○ legal repercussions ○ decrease in productivity, increase in turnover. Understand techniques used to respond to hazardous materials, responding, reporting and communicating the following: (K3.5) • the justification of sampling techniques for different hazardous materials: ○ air sampling (with gas detector, or collection device linked to air pump) ○ a bulk sample of the solid or liquid for analysis ○ wipe sampling or dipping with indicator paper • methods for undertaking sampling on site for different hazardous materials, including: ○ selection of sampling locations for different hazardous materials ○ use of enclosures, water/ surfactant sprays and shadow vacuuming to suppress airborne fibres for different hazardous materials ○ sampling with different equipment, including core sampler, sharp knife, chisel, pliers or screwdriver for different hazardous materials, following operational best practice and safety regulations ○ retrieval of samples, including the sealing of exposed surfaces, use of tapes and fillers, cleaning up of debris, and use of polythene floor covering for different hazardous materials ○ operation and techniques for using sampling and measuring equipment, including safe methods of working: (K4.2) – equipment instruction manuals – best practice for operation of sampling and measuring equipment

Skill content	Knowledge
	○ calibration, maintenance and repair of sampling and measuring equipment: (K4.3, K4.4, K4.5) – follow sampling and measuring equipment manuals and guidance for calibration; maintenance schedules, troubleshooting, repair requirements – visual inspection of tools and equipment – guidance and recommendations of when tools and equipment should be discarded and replaced – for air quality measuring equipment, the following: ▪ identifying alarms, notices and errors ▪ alarm level settings ▪ gas configuration and bump test ▪ sensor principles, calibration and adjustment ▪ instrument test and sensitivity adjustment ▪ change of battery and sensors. Communicate with others, using technical language to operate equipment safely. (E1, E3, D3)
S2.8 Use appropriate techniques to ensure the integrity of samples, including visual inspections of work areas and enclosure risks.	Use different approaches to ensure the integrity of samples, including: ● sample treatment, covering individually-sealed samples, second bagging and unique identifier labelling ● prevention of the disturbance and spread of hazardous materials during sampling by following processes ● safe working procedures for sampling: ○ Health and Safety Executive Document Reference HSG248: Asbestos – The Analyst’s Guide for Sampling, Analysis and Clearance Procedures ○ Health and Safety Executive: ○ HSG264 Asbestos – The Survey Guide ○ the systematic survey should proceed with internal work upwards from the basement to the roof, working around each area, clockwise from the door of entry, reviewing components in the following order: ceiling, walls, floors, fixtures and fittings, equipment and services for on-site sampling of hazardous materials. Collect appropriate samples to enable analysis: (K6.3) ● when taking samples of asbestos cement, a 5cm² sample is recommended in order to determine if the chrysotile asbestos isn’t contaminated by amosite or crocidolite ● selection of sampling locations for different hazardous materials ● use of enclosures, water/surfactant sprays and shadow vacuuming to suppress airborne fibres for different hazardous materials, in accordance with BS 8520 part 1 and 2: 2009

Skill content	Knowledge
	• sampling with different equipment, including core sampler, sharp knife, chisel, pliers or screwdriver for different hazardous materials, following operational best practice and safety regulations • the retrieval of samples, including the sealing of exposed surfaces, use of tapes and fillers, cleaning up of debris and use of polythene floor covering for different hazardous materials.

Assimilating site sampling information to prepare hazardous material sample documentation and records

Skill content	Knowledge
S2.5 Complete required documentation and reports, using digital software.	Demonstrate the ability to complete and present technical hazardous material site inspection reports, using digital software techniques, to a non-technical audience: • consideration of typical errors, presenting the results and recording the location of the hazardous materials site inspection • material risk assessment algorithm, scoring the main factors influencing the release of hazardous materials: ○ material assessment considers the type and condition of the material and the ease by which it can be released, by applying a numerical score to influencing factors such as product type, extent of damage, surface treatment and hazardous material type ○ priority assessment considers the likelihood of disturbing the material, by applying a numerical score to influencing factors such as maintenance activity (planned and unplanned), occupant activity, likelihood of disturbance based on extent and accessibility, human exposure potential based on the number of occupants in an area, frequency of use and average time of use • requirements for communicating information at appropriate times: (K6.2) ○ sample labels ○ site inspection reports ○ preparation of survey plans and how parameters that need to be assessed during the survey are recorded, including information relating to: – location of the material – type of product – accessibility implications – material condition – the presence, or not, of a surface treatment.

Performance Outcome 3: Analyse hazardous materials

Undertaking standard laboratory tests on hazardous materials safely

Skill content	Knowledge
S3.1 Sequence and prioritise task requirements.	Evaluate the advantages and disadvantages of different types of technical equipment to justify the selection of a technique for the laboratory analysis of a hazardous material. Technical equipment will include: • polarised light and transmission light microscopy. Consider advantages and disadvantages: • time implications • smallest fibre size that can be detected • application to composite materials. Follow step-by-step process to conduct analysis of fibre samples: 1. examination at x10–x40 in a stereo microscope for fibres and fibre bundles 2. picking out of examples of the various fibre types seen and mounting in a refractive index liquid between a glass microscope slide and cover slip 3. examination of the optical properties, using polarised light microscopy (PLM) and dispersion staining techniques at magnification of x100 or greater 4. identification of the asbestos type present, based on the observed optical properties. Follow process of setting up the stereo microscope: (K4.9) • Turn the revolving turret so that the lowest power objective lens (e.g. x4) is clicked into position. • Place the microscope slide on the stage and fasten it with the stage clips. • Look at the objective lens and the stage from the side and turn the focus knob so the stage moves upward. Move it up as far as it will go without letting the objective touch the cover slip. • Look through the eyepiece and move the focus knob until the image comes into focus. • Adjust the condenser and light intensity for the greatest amount of light. • Move the microscope slide around until the sample is in the centre of the field of view (what you see). • Use the focus knob to place the sample into focus and readjust the condenser and light intensity for the clearest image (with low power objectives, you might need to reduce the light intensity or shut the condenser).

Skill content	Knowledge
	• When you have a clear image of your sample with the lowest power objective, you can change to the next objective lenses. You might need to readjust the sample into focus and/or readjust the condenser and light intensity. If you cannot focus on your specimen, repeat the previous three steps with the higher power objective lens in place. Do not let the objective lens touch the slide! • When finished, lower the stage, click the low power lens into position and remove the slide.
S3.3 Convey information, data and outcomes, using appropriate techniques.	Explain the physics governing polarised light and transmission electron microscopy. Convey technical information to others and present information to others through reports. (E1, E2) Use spreadsheet software to convey data to conduct calculations for lab work. (D1, D4)
S3.4 Use chemical preparations, morphology and composition, phase contrast microscopy and fibre counting.	Carry out preparatory procedures for identifying hazardous material in samples by polarised light and transmission light microscopy, including the following: (K7.1) • process for chemical preparations: ○ preparing samples by crushing, acid washing or treatment ○ use of organic solvents to remove bitumen or plastic matrices ○ low-temperature ashing • process for morphology and composition: ○ use of reagents to identify asbestos fibres, including acetic acid, hydrochloric acid, sodium hydroxide and acetone ○ dispersion stain technique • use of test slides: ○ HSE/NPL Mark II test slide.
S3.2 Analyse samples, using appropriate techniques.	Apply safe working practice for analysis of samples using microscopes: • open sealed sample bags in fume cabinet and catalogue • carry out preliminary visual inspection of the complete bulk sample • isolate or release fibre from sample, using tweezers or pliers • view under stereo microscope to classify the fibre types present • determine the required refractive index (RI) liquid • mount representative fibres on microscope slides in appropriate refraction index (RI) liquids and rotate under filters

Skill content	Knowledge
	• identify different fibrous components, using phase-contrast light microscopy • dispose of the slide in a sealed bag, and place it in a glass disposal bin • apply safety-conscious behaviours during analysis – sample and material controls in accordance with health and safety regulation and best practice. (K1.6) Identify and describe fibres by polarised light and transmission electron microscopy, covering the following: • implications of poor health and safety performance (ethical, legal, financial): (K1.2) ○ the 'health and safety iceberg' ○ increased risk of ill health, injury and death ○ loss of reputation ○ legal repercussions ○ decrease in productivity, increase in turnover • risk management in the analysis processes: (K1.5) ○ non-asbestos hazards – working at height (in ceiling voids or on a fragile roof), working on operable machinery or plant, working in confined spaces, chemical hazards, electrical hazards, biological hazards, noise hazards and lone working ○ asbestos issues – preventing disturbance and spread of asbestos-containing materials, safe working procedures for sampling, PPE, decontamination and disposal arrangements, risk management in analysis processes • identification of vitreous, crystalline and amorphous materials by polarised light, considering: ○ colour ○ elasticity and morphology of different fibre types ○ hydrophobic and hydrophilic properties ○ pleochroism ○ birefringence ○ signs of elongation and extinction • expected observations and results with different hazardous material types • errors in fibre identification • fibres that display similar properties to other materials under the microscope – cobwebs, leather, skin cells • known difficulties with identifying certain materials

Skill content	Knowledge
	• process for fibre counting: ○ Walton-Beckett graticule eyepiece ○ set-up and calibration of graticule ○ selection of graticule area for counting ○ selection of fields ○ rules for counting fibre – a field should be rejected if a filter grid line obstructs all or part of the view • potential sources of error when analysing samples within a laboratory: ○ sample size ○ non-homogenous and trace content samples ○ analyst fatigue ○ eye strain ○ detection limits ○ cross-contamination during handling of samples and analysis ○ bright sunlight obscuring slides. Communicate and convey technical information to others on how to operate equipment safely. (E1, E3)
S3.11 Inspect the suitability of scientific tools and equipment.	Explain the inspection, maintenance, calibration and repair of laboratory equipment used for the identification of hazardous materials, including the reasons for use and the industry operational standards, covering: (K4.6, K4.7, K4.8, E1, E3) • microscopes and optics principles of inspection, maintenance, calibration and repair, covered in ISO 8039: 2014 and BS EN ISO 17025: 2017 • fume cabinet principles of inspection, maintenance, calibration and repair, covered in BS 7258-1: 1994 • hot plates • class H vacuum cleaner inspection, principles of inspection, maintenance and repair, covered in BS 8520-3: 2009 • sampling and measuring equipment principles of inspection, maintenance, calibration and repair in accordance with ISO 17025: 2005.
S3.6 Operate equipment safely.	Explain the importance of procedures and systems for maintaining safety during hazardous material analysis using microscopes, (K1.6) including: • use of fume cabinets • glove boxes • safe use of chemicals • selection of personal protective equipment.

Skill content	Knowledge
S3.7 Apply safe processes to waste disposal.	Explain the procedure for the management and safe disposal of laboratory samples, including the following: (K7.2) • legal requirements, including the principles set out in regulations, the materials to which they apply and approved methods of disposal: ○ the Waste (England and Wales) (Amendment) Regulations 2012 ○ the Hazardous Waste (England and Wales) Regulations 2005 ○ the Waste Electrical and Electronic Equipment Regulations 2013 with amendments • sample storage • UKAS requirements • health, safety and welfare • damage to the environment • cost implications.
S3.5 Apply appropriate mathematical techniques. S3.10 Use appropriate techniques to check accuracy of analysis and predictive models.	Apply statistical and trigonometric techniques to interoperate sample information appropriately: • calculation of fibre concentration. Understand factors contributing to poor precision: • statistical variation • systematic variation • subjective variation. Understand techniques to check the accuracy of analysis and predictive models, including the following: • reporting restrictions on analytical results outside the optimal range • background contamination levels • that microscopy methods are qualitative and not quantitative, and the importance of this distinction • Poisson distribution and coefficient of variation for fibre counting.

Preparation of laboratory test reports for hazardous materials

Skill content	Knowledge
S3.9 Select information and data, and present using techniques appropriate to the audience.	Demonstrate the ability to complete and present, with the use of digital software, technical hazardous material laboratory reports to a non-technical audience. The reports should: • consider typical errors and how to present the results, and record the location of hazardous materials • include a material assessment algorithm, scoring the main factors influencing the release of hazardous materials.
S3.8 Manage the confidentiality and security of information and data.	Evaluate the importance of, and explain procedures for, the protection of confidential information, including: • commercial business requirements • controlled access • use of confidential waste bins and lockable storage cabinets • privacy and confidentiality of client data and costing information. • whistleblowing policy and method of escalating information. (K9.3)

Performance Outcome 4: Monitor hazardous materials

Techniques to manage retained hazardous materials within the built environment

Skill content	Knowledge
S4.2 Interpret information and data, including from visual and other sources, to identify issues. S4.1 Verify suitability of information and data from appropriate sources specific to the scope of works. S4.4 Provide information, advice and guidance, using appropriate communication techniques.	Evaluate and interpret laboratory sample test results and site inspection reports to justify a strategy for managing hazardous materials, including the selection of appropriate monitoring equipment: • asbestos-containing material or not • risk rating: ○ potential for future damage and contamination • recommendations: ○ leave in situ and manage ○ repair damage and manage ○ remove. Verification of reports: • lab has UKAS accreditation for bulk sampling and fibre counting • RICE (Random Interlaboratory Counting Exchange) Scheme assessment. Explain how hazardous materials will be managed safely in the built environment, including techniques and equipment for monitoring, decontamination, removal and disposal: (K8.2) • specialist monitoring equipment, its characteristics and how it is operated, including gas monitoring equipment with colorimetric gas detection tubes, air quality monitoring, asbestos fibre air monitoring (K4.10) • operation of specialist plant and machinery: ○ operational manuals and guidance for individuals, plant and machinery (K4.14) • the techniques used for repairing equipment: (K4.13) ○ identifying alarms, notices and errors ○ alarm level settings ○ gas configuration and bump test ○ sensor principles, calibration and adjustment ○ instrument test and sensitivity adjustment ○ change of battery and sensors. • the importance of maintaining, calibrating and storing monitoring equipment: (K4.11, K4.12) ○ follow instruction manual guidance for maintenance, calibration and storage of equipment ○ failure to follow guidance could lead to: – decline of performance of monitoring equipment – break down of equipment – inaccurate results – safety being affected.

Skill content	Knowledge
	• decontamination methods – physical and chemical means of decontamination: (K8.1) ○ heat ○ liquid disinfection ○ vapours and gases ○ radiation • appropriate communication techniques – reports/BIM • advising stakeholders on requirements for monitoring responsibilities. Present ideas by conveying them through management plans to summarise next steps. (E1, E2, E4)
S4.3 Negotiate requirements with stakeholders.	Negotiate and agree the strategy for managing hazardous materials with key stakeholders, including: (K8.3) • methods for conveying and presenting information to stakeholders, including: (K9.1) ○ technical reports (E1, E2) ○ asbestos registers and how the information in the asbestos register will be used ○ how survey data will be stored, assessed and updated • stakeholders: ○ client ○ building occupiers/users – contractors – visitors – staff ○ local authority ○ Health and Safety Executive. Communicate with clients through digital means such as email. (D1, D3) Communicate with clients using technical language and professional approach in communications. (E1, E2, E3)

Skill content	Knowledge
S4.5 Present technical information for different types of stakeholder.	Justify and prepare suitable documentation to record the management of hazardous material within the built environment, including: • hazardous material registers • hazardous material management plan • waste disposal procedures • use of document control register to ensure information is distributed correctly to stakeholders while maintaining appropriate privacy and confidentiality. (K9.2) Understand key parts of a management plan, including: (K9.1) • communication with contractors and visitors: ○ requirements for personnel entering the building, including contractors and visitors ○ training of personnel • signage and labelling of hazardous materials: ○ access restrictions to the building ○ building maintenance policy ○ permit to work schemes ○ safe systems of work ○ restrictive and prioritised access • emergency response procedures • hazardous material registers: ○ written plan of control actions, covering protection enclosure, sealing, encapsulation and repair ○ strategies for monitoring the condition of building elements containing hazardous materials in situ • legislation and best practice for maintenance, control and disposal • implications of poor health and safety management (ethical, legal, financial): (K1.2) ○ the 'health and safety iceberg' ○ increased risk of ill health, injury and death ○ loss of reputation ○ legal repercussions ○ decrease in productivity ○ increase in turnover.

Scheme of Assessment – Hazardous Materials Analysis and Surveying

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* consists of four Occupational Specialist Components:

1. Surveying and Design for Construction and the Built Environment
2. Civil Engineering
3. Building Services Design

4. Hazardous Materials Analysis and Surveying

Students will be able to take **one** of the Occupational Specialist Components as part of their *T Level Technical Qualification in Design, Surveying and Planning for Construction*.

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: Hazardous Materials Analysis and Surveying
Externally assessed project: 15.5 hours 100% of the Occupational Specialist Component assessment 180 marks Graded P, M and D
Content overview Students are required to: • inspect the built environment • identify hazardous materials • analyse hazardous materials • monitor hazardous materials.
Assessment overview This project will be set by Pearson and externally marked by Pearson. Students will respond to a client brief to inspect a site, identify hazardous materials, analyse these materials, and show how the hazardous materials will be monitored. All practical tasks will be simulated. The project will show students implementing skills in tasks such as: Task 1: Students will complete an initial, desk based, risk assessment of the site to consider potential hazardous materials. Students will complete a report detailing how a preliminary walk through inspection of the identified site should be carried out, including production of an inspection record appropriate to the site.

Task 2a: Students will prepare a Risk assessment based on a video walk through of the site for the inspection of and sampling at the site.

Task 2b: A Student will prepare a method statement to complete an inspection of a site shown in a video.

Task 3a: Students will produce a detailed plan of how to survey the indicated location for a suspected hazardous material.

Task 3b: Students will conduct a simulated sample collection practical in the simulated environment.

Task 4a: Students will conduct simulated laboratory analysis of the hazardous material

Task 4b: Students will complete a laboratory report analysing microscope images and recorded data relating to a hazardous material. The report will include recommendations to the client.

Task 5: Students will produce a material register and management plan. Students will communicate with stakeholders about monitoring plans.

The project will consist of a portfolio of evidence that includes observation reports to evidence practical skills, in order to meet threshold competence where appropriate. This will be accompanied by video evidence.

Timings and scheduling

Task	Assessment session	Assessment scheduling	Time
Task 1	1	Taken on a day specified by Pearson, with all students beginning the task at the same time. Centres may arrange a supervised rest break as appropriate.	3h 0m
Task 2a	2	Taken in a single session at a time specified by Pearson.	2h 0 m
Task 2b	3	Taken in a single session at a time specified by Pearson.	3h 0 m
Task 3a	4	Taken in a single session at a time specified by Pearson.	1h 15m
Task 3b	5	Observation and recording of a practical activity, completed in an individual slot scheduled by the Provider within a one-week window.	0h 15m (slot)
Task 4a	6	Observation and recording of a practical activity, completed in an individual slot scheduled by the Provider within a one-week window.	1h 0m (slot)
Task 4b	7	Taken in a single session at a time specified by Pearson.	2h 0m
Task 5	8	Taken in a single session at a time specified by Pearson.	3h 0m

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* 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 Outcomes

In this assessment, students will:

Hazardous Materials Analysis and Surveying		
Performance Outcome	Descriptor	Weightings
1	Inspect the built environment	40%
2	Identify hazardous materials	23%
3	Analyse hazardous materials	17%
4	Monitor hazardous materials	20%

Preparation for assessment

Students will submit their evidence for tasks as hard copy or as an electronic/digital submission. For an electronic/digital submission, 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 – word processing software.
1	b	
2	a	Digital submission – word processing software.
2	b	Digital submission – word processing software.
3	a	Digital submission – word processing software, video and observation submission.
3	b	
4	a	Digital submission – video submission.
4	b	Digital submission – word processing software and spreadsheet software.
5	a	Digital submission – word processing software.
5	b	

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

Task	Preparation work needed
Task 2a	The tutor will need to ensure that they have the equipment available to play the video for the cohort of students.
Task 3a	Access to location/room required for Task 3b.
Task 3b	In preparation for the task, the tutor will need to source a location/room and ensure that the sampling equipment, for example cork borer, particle counter, is available for the session. The required equipment and material will differ in every series. This task will need to be monitored by the tutor. Video equipment is needed for the assessment as the tutor is required to video it.
Task 3	The tutor will need to source video-recording equipment before the assessment takes place and have it available for the assessment.
Task 4a	In preparation for the task, the tutor will need to ensure that there is a suitable environment in which students can conduct laboratory work; the environment should be clean and well equipped. Students should have access to the following equipment: • personal protective equipment • light microscope • material to be examined • microscope slides for preparation • oil immersion • lens tissue. You will be informed, prior to the assessment, of the material you will need to source for the practical analysis. The teacher must not share the information with students.

9. Resources for the delivery of this Technical Qualification

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

Hazardous materials:

- video recording equipment
- surveying equipment
- dust/fume cabinet
- stereo microscope
- polarising light microscope

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

10. Technical Qualification grading, T Level grading and results reporting

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* will be graded and awarded to comply with the requirements of Ofqual's General Conditions of Recognition.

Calculation of the Technical Qualification grade

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

Component	Available grade range
Core	A*–E and Unclassified
Occupational Specialist	Unclassified, Pass, Merit, Distinction

The Core Component uses an aggregation of points from each of the three Core Assessments to calculate the A* to E.

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

Awarding the Core Component

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

Uniform Mark Scale

Students' raw sub-component marks will be converted to a Uniform Mark Scale (UMS). The UMS is used to convert students' sub-component 'raw' marks into uniform marks. This is done in order to standardise marks from one series to another as assessments may vary in difficulty. For example, a student who achieves the lowest mark worthy of a C grade in the Employer Set Project 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 in the following table:

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

The Core Examination has two exam papers, the results of which are combined before conversion to UMS.

Calculation of the T Level grade

The *Calculation of qualification grade* table below shows the minimum thresholds for calculating the T Level grade, subject to successful completion of all elements. The table will be kept under review over the lifetime of the T Level.

Calculation of qualification grade			
	Occupational specialism grade		
Core grade	Distinction	Merit	Pass
A*	Distinction*	Distinction	Distinction
A	Distinction	Distinction	Merit
B	Distinction	Merit	Merit
C	Merit	Merit	Pass
D	Merit	Pass	Pass
E	Pass	Pass	Pass

Students who do not meet the minimum requirements for a T Level to be awarded will not be certificated. They may receive a Notification of Performance for individual components.

In order to be awarded the T Level, a student 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 as required by the Institute for Apprenticeships and Technical Education (the Institute) and the T Level panel, such as 315 hours of industry placement.

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

Results reporting

The *T Level Technical Qualification in Design, Surveying and Planning for Construction* forms the substantive part of the Construction: Design, Surveying and Planning T Level programme. The T Level programme includes other elements that are required to be successfully completed in order for students to be awarded the T Level from the Institute. The Institute will provide T Level certificates to students who successfully complete all elements of the T Level programme.

The Institute will issue T Level results on Level 3 results day in August.

Pearson are not required to issue Technical Qualification certificates to students; instead we will provide component results for assessments that students undertake.

Pearson will issue component results on the results day designated for each assessment window.

11. Entry, delivery and assessment information

Introduction

This section focuses on the key information to deliver the *T Level Technical Qualification in Design, Surveying and Planning for Construction*. is of particular value to programme leaders and examinations officers, who must ensure appropriate arrangements are made for assessments.

Student registration

Shortly after students start their T Level programme, you must make sure they are registered for the Technical Qualification. You will be required to register students as outlined in our Key Dates Schedule, which will be published annually on our T Level webpage.

At the point of registration onto the Technical Qualification, we will ask you to confirm the Occupational Specialist Component(s) the student has chosen to study, or as a minimum provide an indication.

Students can be formally assessed only for a qualification on which they are registered.

If students' intended qualifications change – for example, if a student decides to choose a different occupational specialism – then the Provider must transfer the student appropriately.

Programme delivery

You are free to deliver this Technical Qualification using any form of delivery that meets the needs of your students. We recommend making use of a wide variety of modes, including direct instruction in classrooms or work environments, investigative and practical work, group and peer work, private study and e-learning.

Availability of live assessment

The assessments for the *T Level Technical Qualification in Design, Surveying and Planning for Construction* will be scheduled annually as shown in the table below:

Annual Series for Design, Surveying and Planning for Construction					
Component	First assessment	Month(s)	Window/ set date	Exam type	Paper/ on-screen
Core 1	2021	May/June November	Set date and time	Written examination	Paper
Core 2	2021	May/June November	Set date and time	Written examination	Paper
Employer Set Project	2021	May/June November	Task specific: window/set date and time	Task	Paper
Occupational Specialist	2022	May/June	Task specific: window/set date and time	Task	Paper

In developing an overall plan for delivery and assessment for the qualification, you will need to consider the order in which you deliver the content and when the assessments will take place.

Students must be prepared for external assessment by the time they undertake it. In preparing students for assessment, you will want to take account of required learning time, the relationship with other external assessments and opportunities for retaking.

Language of assessment

Assessment of this qualification will be available in English. All student work must be in English.

Student assessment entry

You must enter students into an assessment window, either for the Core Component or the Occupational Specialist Component, as outlined in our Key dates Schedule.

For the first attempt for the Core Component, you will need to make an entry for **both** the Core examination **and** the Employer Set Project in the same window (i.e. May/June **or** November).

For a resit, students can take the Core examination and/or the Employer Set Project in a separate window. Therefore, you will need to make an entry for the window you require the student to resit the assessment in.

For the Occupational Specialist Component, you will need to make an entry for the window the student wishes to sit the assessment in.

Resit arrangements

As per the Ofqual Technical Qualification Handbook, there is no specific resit window permitted. However, students will be able to resit in any assessment window following their first sitting.

Students may resit:

- the Core assessment(s)
- the Employer Set Project
- the assessments for an occupational specialism, or
- any combination of these.

Where a student fails one of the Core assessments, they must resit both assessments and must do so in the same assessment window.

However, where a student has to resit both the Core assessment and the Employer Set Project, they do not need to retake both sets of assessments in the same assessment window. For clarity, where a student resits the Core assessment, he or she is not required to retake the Employer Set Project, and vice versa.

In order to access a resit opportunity, you will need to make an entry for the window you require the student to resit the assessment in; see *Student assessment entry* above.

Resits can take place up until two academic years after the end of the final academic year for the cohort within which the relevant student is included.

Access to qualifications and assessments for students with disabilities or specific needs

Assessments need to be administered carefully to ensure that all students are treated fairly, and that results are issued on time to allow students to progress to their chosen progression opportunities.

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

- students with a protected characteristic (as defined by the Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for undertaking a qualification, and that this achievement can be compared fairly to the achievement of their peers.

For students with disabilities and specific needs, the assessment of their potential to achieve the qualification must identify, where appropriate, the support that will be made available to them during delivery and assessment of the qualification. Please see information below on reasonable adjustments and special consideration.

Further information on access arrangements can be found in the Joint Council for Qualifications (JCQ) document *Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational Qualifications*.

Special requirements

Some students may have special needs during their Technical Qualification assessments. In such cases, Providers can apply for special requirements on their behalf.

We have a dedicated webpage for [Special Requirements](#). This includes:

- reasonable adjustments
- access arrangements
- special consideration
- modified formats.

Reasonable adjustments to assessment

The Equality Act 2010 requires an awarding organisation to make reasonable adjustments where a student with a disability would be at a substantial disadvantage in undertaking an assessment.

To ensure students have fair access to demonstrate the requirements of the assessments, a reasonable adjustment is one that is made before a student takes an assessment. In most cases, this can be achieved through a defined time extension or by adjusting the format of evidence. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable. You need to plan for time to make adjustments if necessary.

We have a dedicated webpage for [reasonable adjustment](#) where Providers can learn more about the process and apply on behalf of a student.

Reasonable adjustments can help reduce the effects of a disability or difficulty that puts the student at a substantial disadvantage in an assessment, in order to enable them to demonstrate their knowledge, understanding, skills and behaviours to the level of attainment required.

Providers can access the *Application of Reasonable Adjustment for Technical Qualifications* via our dedicated webpage. The Provider's application must be made in line with the policy and a copy of their application must be retained.

For this qualification we do not see anything that might prevent reasonable adjustment providing the student is still able to demonstrate the achievement of the skills being assessed. This is due to the fact that students must achieve threshold competence. As a result there could be some Assessment Objectives and/or Performance Outcomes that must be met as they are mandatory in order to demonstrate threshold competence and meet the requirements for the sector.

Access arrangements

We also have a dedicated webpage for [access arrangements](#), where Providers can learn more about arrangements available for students with special needs. Access arrangements aim to meet the particular needs of an individual student without affecting the integrity of the assessment.

Access arrangements allow students to show what they know and do without changing the integrity or the demands of the assessment, for example by using a reader or scribe. Access arrangements are approved before an examination or assessment and they allow students with special educational needs, disabilities or temporary injuries to access the assessment.

Special needs could include students:

- with known and long-standing learning difficulties
- with physical disabilities (permanent or temporary)
- with sensory impairment
- whose first language is not English
- who have difficulties at or near the time of assessment that may affect their performance in the assessment.

For more information about access arrangements, we suggest Providers refer to the JCQ booklet *Access Arrangements, Reasonable Adjustments*.

Special consideration

A student's assessment performance can sometimes be affected by circumstances out of their control. Special consideration is a post-examination adjustment that compensates students who were suffering from a temporary illness or condition, or who were otherwise disadvantaged at the time of the Technical Qualification assessment.

Exams officers may apply for special consideration on a student's behalf. We have a dedicated webpage for [special consideration](#). This includes an FAQ fact sheet giving Providers answers to any questions or concerns they may have.

Special consideration will adhere to the following:

- There are general guidelines for special consideration in the JCQ booklet *A guide to the special consideration process*. It covers the process that is applied consistently by all Awarding Organisations. AOs will not enter into discussion with students or their parents as to how much special consideration should be applied.
- Special consideration cannot be applied in a cumulative fashion, i.e. on the basis of a domestic crisis at the time of the exam and the student suffering from a viral illness.
- Private students should liaise with the Provider where entries have been made, so that they can apply for special consideration on the private student's behalf.

Dealing with malpractice in assessment

We adhere to the JCQ document *Suspected Malpractice in Examinations and Assessments* in our approach to investigating potential malpractice or breaches of security. These procedures are in line with the Ofqual Conditions of Recognition. All allegations of potential malpractice are investigated, and sanctions imposed where malpractice is proven.

We have two dedicated webpages concerning malpractice:

- The first gives Providers guidance on how to let us know about anything suspicious or incidents of malpractice, in accordance with JCQ regulations.
- The second gives students information about what malpractice is and how to report it.

What does malpractice mean?

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

Pearson does not tolerate actions (or attempted actions) of malpractice by students, Provider staff or Providers in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on students, Provider staff or Providers where incidents (or attempted incidents) of malpractice have been proven.

Malpractice may arise or be suspected in relation to any unit or type of assessment within the qualification. For further details regarding malpractice and advice on preventing malpractice by students, please see Pearson's *Provider guidance: Dealing with malpractice and maladministration in vocational qualifications*, available on our [website](#).

Providers are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Students must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the Provider. The *Provider guidance: Dealing with malpractice and maladministration in vocational qualifications* document gives comprehensive information on the actions we expect you to take.

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

In the interests of students and Provider staff, Providers need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

Student malpractice

Student malpractice refers to any act by a student that compromises or seeks to compromise the process of assessment, or which undermines the integrity of the qualifications or the validity of results.

Student malpractice in examinations **must** be reported to Pearson using a *JCQ Form M1* (available at www.jcq.org.uk/exams-office/malpractice). The form should be emailed to studentmalpractice@pearson.com. Please provide as much information and supporting documentation as possible. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice constitutes staff or Provider malpractice.

Tutor/Provider malpractice

Providers are required to inform Pearson's Investigation Team of any incident of suspected malpractice by staff before any investigation is undertaken. Providers are requested to inform the Investigation Team by submitting a JCQ M2(a) form (downloadable from www.jcq.org.uk/malpractice) with supporting documentation to pqsmalpractice@pearson.com.

Where Pearson receives allegations of malpractice from other sources (for example, Pearson staff or anonymous informants), the Investigation Team will conduct the investigation directly or may ask the Provider to assist.

Incidents of maladministration (accidental errors in the delivery of Pearson qualifications that may affect the assessment of students) must also be reported to the Investigation Team using the same method.

Heads of Providers/Principals/Chief Executive Officers or their nominees are required to inform students and Provider staff suspected of malpractice of their responsibilities and rights; see 6.15 of *JCQ Suspected Malpractice in Examinations and Assessments Policies and Procedures*.

In cases of suspected malpractice, Pearson reserves the right to withhold the issuing of results while an investigation is in progress. Depending on the outcome of the investigation, results may be released or withheld.

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

Results transfer to Providers

To ensure you are supported, we will communicate with you on and before results day.

Results day will follow the format below:

Assessment Window	Results day
Summer 2021	August 2021 (Level 3 results day)
November 2021	January/February 2022

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

We will 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.

Post-Results Services

Our Technical Qualification post-results services (PRS) and appeals will be implemented in line with Ofqual requirements, paying particular attention to the *Rules and Guidance for Technical Qualifications*, where sections Ofqual TQ13–23 refer to post-results activities, ‘Review of Marking or Moderation’ (RoMM) or Appeals.

We will provide the following:

- access to student assessment evidence
- appeal
- clerical checks
- expedited review of marking
- review of marking.

Our [post-results services](#) webpage will include all the necessary information for you to access the services for the T Level Technical Qualification. There will also be a specific *T Level Technical Qualification Post-Results Service Guide* for Providers to use following our first live assessment series in 2021. This information should be used alongside the *JCQ Post-Results Service Guide*.

PRS will be available after each assessment opportunity. Exams officers will be able to apply for PRS via our online system; however, you must have permission from the student before applying. If a student wishes to apply for PRS they must do so via their Provider. We state within the PRS guidance on our website that we cannot accept appeals directly from students, their parents or other third parties acting on their behalf.

In addition, our unique Results Plus service and a free Access to Scripts service will be available, so that Providers are able to transparently see how marks are awarded.

Appeals process

Our appeals process for the Technical Qualification will reflect industry standards, as outlined by the relevant Ofqual Condition(s) (TQ17–TQ22) relating to appeals.

You will be able to appeal the outcome of marking, decisions made regarding reasonable adjustments or special consideration tariffs applied, and any consequence of malpractice or maladministration investigations by us or other Technical Qualification AOs.

All our investigations will be conducted in accordance with the *JCQ General and Vocational Qualifications Suspected Malpractice in Examinations and Assessments Policies and Procedures*.

12. Provider recognition and approval

Introduction

Our Provider approval process and criteria have been developed in collaboration with other awarding organisations offering Technical Qualifications to ensure you have a seamless experience across awarding organisations when requesting approval to deliver the Technical Qualification.

Approving Eligible Providers as Approved Providers

Eligible Providers, i.e. those who submitted an Intention to Teach and have been approved by the DfE to deliver T Levels, will be required to seek approval from Pearson for each Technical Qualification they wish to deliver. They will do this by completing **one** of the two Provider Application forms:

5. T Level Technical Qualification Delivery Approval Application Form
6. Pearson UK Vocational Provider Approval Application for T Level Technical Qualifications.

The first form is for existing vocational Pearson centres to gain approval to deliver the Technical Qualification.

The second form is for non-vocational Pearson centres, i.e. centres not delivering any other vocational Pearson qualification. These are **new** Providers applying for centre approval to deliver vocational qualifications and the T Level Technical Qualification.

In order to assist **new** Providers in their application process, we have provided additional guidance: *Guidance to assist in the completion of the Pearson Vocational Provider Approval Application for T Level Technical Qualifications*.

In addition, we will also support you in the following ways:

- phone support via our Approvals Team
- on-boarding training via Provider Support.

Provider and Technical Qualification approval

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

- Providers must have appropriate physical resources (for example, equipment, IT, learning materials, teaching rooms) to support the delivery and assessment of the qualification.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification.
- Providers must have in place appropriate health and safety policies relating to the use of equipment by students.
- Providers must deliver the qualification in accordance with current equality and diversity legislation and/or regulations.
- Providers should refer to the Resources for delivery of content section in the components to check for any specific resources required.
- Administration arrangements, including security of live assessments, must be in place.

The methods we use to ensure Providers have the above resources in place include:

- making sure that all Providers complete appropriate declarations at the time of approval
- undertaking approval visits to Providers
- an overarching review and assessment of a Provider's strategy for delivering and quality assuring its technical qualifications.

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

What level of sector knowledge is needed to teach this qualification?

We do not set any requirements for tutors, but recommend that Providers assess the overall skills and knowledge of the teaching team to ensure that they are relevant and up to date. This will give students a rich programme to prepare them for employment in the sector.

For this Technical Qualification, tutors with the following knowledge and skills will be beneficial to the delivery of the programme:

Core component:

- Qualified to HN (level 4) or above, in construction, or
- 5 Years of experience working at the appropriate level in the construction sector, or
- Membership of an appropriate professional body allied to the construction sector, or
- 3 years' experience in teaching in the construction subject area.

Teachers that are familiar with Level 3 construction qualifications will be able to teach all core topics but should have:

- Experience of delivering project based qualifications
- Experience of preparing students for examination based assessment

- Knowledge of emerging technologies and sustainability.

CAD may be taught by an expert outside of construction.

Civil Engineering:

- Qualified to HN (level 4) or above, in construction, or
- 5 Years of experience working at the appropriate level in the construction sector, or
- Membership of an appropriate professional body allied to the construction sector, or
- 3 years' experience in teaching in the construction subject area.

Teachers should have:

- Experience of delivering project based qualifications
- Experience of preparing students for examination based assessment
- Knowledge of emerging technologies and sustainability

The maths and science components may also be taught by a construction 'maths/science' expert.

CAD may also be taught by an expert outside of construction.

Surveying and design:

- Qualified to HN (level 4) or above, in construction, or
- 5 Years of experience working at the appropriate level in the construction sector, or
- Membership of an appropriate professional body allied to the construction sector, or
- 3 years' experience in teaching in the construction subject area.

Teachers should have:

- Experience of delivering project based qualifications
- Experience of preparing students for examination based assessment
- Knowledge of emerging technologies and sustainability

For the CAD and modelling content a non-construction specialist could be used to deliver.

Building Services Design:

- Qualified to HN (level 4) or above, in construction, or
- 5 Years of experience working at the appropriate level in the construction sector, or
- Membership of an appropriate professional body allied to the construction sector, or
- 3 years' experience in teaching in the Building Services Engineering subject area.

Teachers should have:

- Experience of delivering project based qualifications
- Experience of preparing students for examination based assessment
- Knowledge of emerging technologies and sustainability

For the CAD and modelling content a non-construction specialist could be used to deliver.

Teachers with level 3 or above qualifications in specific Building services such as Electrical installations or Plumbing can be used can teach the relevant services in Building Services Design.

Hazardous Materials Analysis and Surveying:

For teaching of the 'Hazardous Materials Analysis and Surveying' specialism, the teacher should be familiar as a minimum with the Level 3 construction qualifications.

Teachers should have:

- Experience of delivering project based qualifications
- Experience of preparing students for examination based assessment
- Knowledge of emerging technologies and sustainability

Teachers must hold the following qualifications:

- A minimum of the foundation BOHS courses in Asbestos surveying and analysis and Basic principles in occupational hygiene.

What resources are required to deliver this qualification?

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.

Providers should refer to the *Resources for delivery of content* section in the components to check for any specific resources required.

Quality Assurance for the delivery of the Technical Qualification

All Providers will be subject to the same level of scrutiny for the delivery of the Technical Qualification.

We will monitor you throughout the delivery of the contract. This is to ensure you have appropriate and consistent quality assurance measures in place for the delivery of the Technical Qualification, and to ensure that you maintain ongoing compliance with our quality assurance measures in order to retain your approval status.

To maintain ongoing quality, give support and monitor standards, you will receive a termly phone call, and support visit if necessary, from a Provider Quality Manager (PQM). The PQM will check the quality of delivery, confirm implementation of guide/grade exemplification materials, and confirm you are on track for assessment and are accessing our Provider Support.

We will monitor the following activity that could impact approval status:

- registration patterns
- student outcomes
- quality issues identified by our PQM
- reports of maladministration or malpractice.

The PQM will identify any concerns during the termly phone call, provide support and escalate as required. In order to resolve any issues you may have in meeting our quality assurance measures, the PQM will create an action plan with goals and timescales, and support you through the process. If you do not make adequate progress against the action plan, we will notify the Institute of our intention to remove approval status.

Live assessment monitoring

Each assessment in the Technical Qualification is set and marked by Pearson.

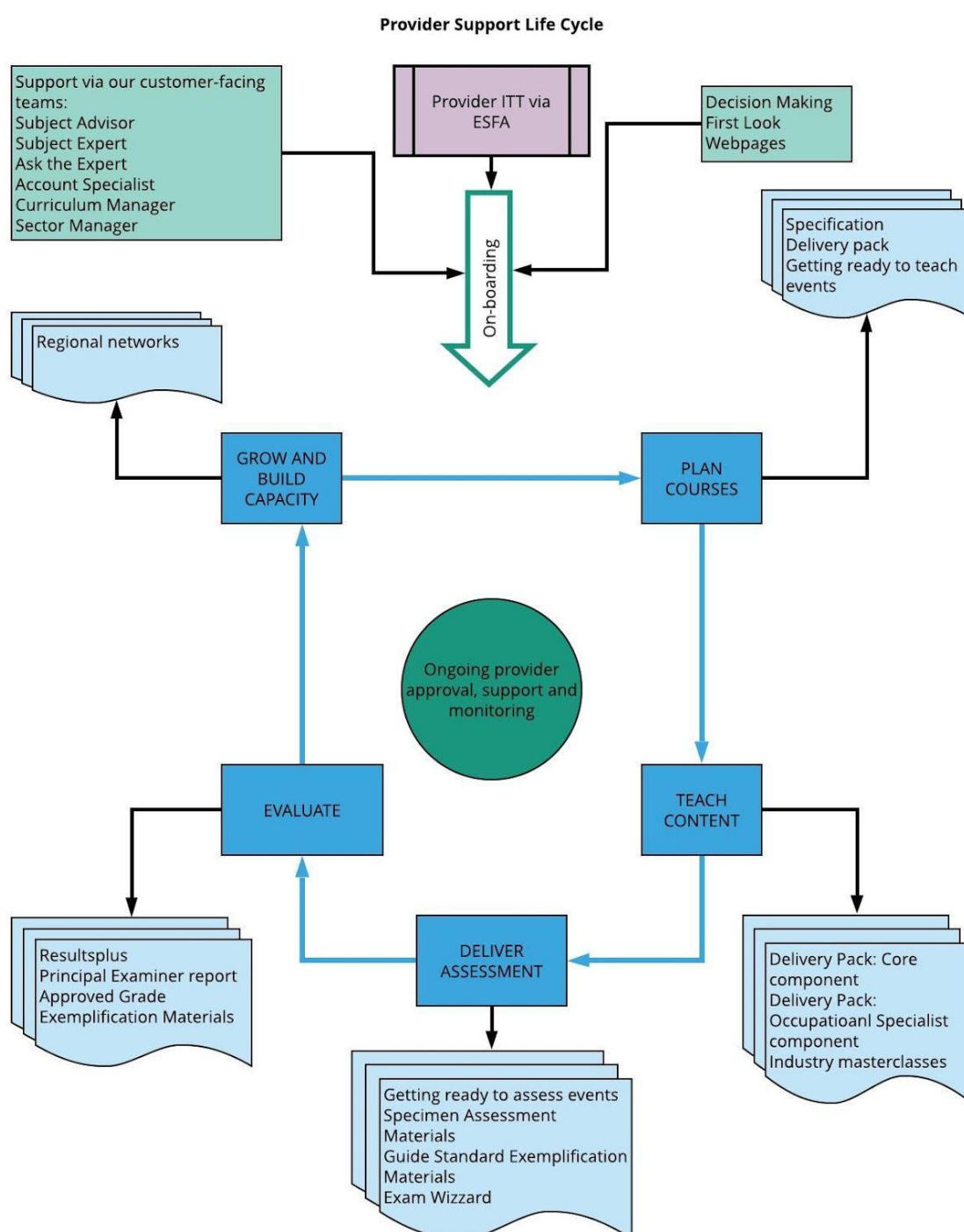
The Core examinations and the Employer Set Project will be sat under exam conditions, following JCQ's *ICE guidance*.

The Occupational Specialist project has different controls depending on the tasks being undertaken by the student. Therefore, full detail of student monitoring will be provided within the assessment materials; these will be published on our T Level webpage before the assessment window commences.

13. Resources and support

The Technical Qualification represents a significant change. It will change how you recruit students, who teaches the occupational specialism, how you incorporate the industry placement, and how you teach and prepare students for external assessment. We will create an innovative range of bespoke support for admin/exams officers, tutors and students that accounts for the step-change the reforms are looking to make in teaching and learning technical skills.

Our aim is to give you a range of support centred on the assessment life cycle, to enable you to deliver the Technical Qualification with confidence. We will include details about our support on our website and inform you via our regular e-bulletins as the materials are launched.



Teaching, learning and assessment materials

1. Plan

- Specification for 2020: content elaboration for the Core and Occupational Specialist Components, guidance and support.
- Delivery Pack: for each component, a Delivery Pack introduction providing advice, help and inspiration.
- Onboarding materials: Provider journey from initial enquiry through to results.

2. Teach

- Delivery Pack: for the Core Component, a number of Topic Guides with lesson activities, industry links and topics linked to assessment.
- Delivery Pack: for the Occupational Specialist Component, an industry project designed with our EVP to enable holistic delivery of the occupational specialism to enhance student experience and prepare for synoptic assessment; used 'off the shelf' or adapted for local or student needs.

3. Assess

- Specimen Assessment Materials (SAMs).
- Guide Standard Exemplification Materials (GSEM).

4. Evaluate

- Principal examiner (PE) report for each component: commentary on performance, including Approved Grade Standard Exemplification Materials.

With the exception of the PE reports, materials will be developed alongside the Technical Qualification. From April 2020 we will have a phased launch of our Provider Support, depending on the resource and where it features within the teaching or assessment life cycle; this is aimed at ensuring you have time to plan, yet aren't bombarded with materials and events within close proximity of each other.

Provider training

Our training will incorporate the above teaching, learning and assessment materials and allow for an in-depth look at content, pedagogy and assessment, providing an opportunity for tutors to network, share ideas and unpick common issues.

The events are targeted at a variety of roles and fit into the Provider journey as follows:

1. Plan

- Admin/Exams Officer: set-up and support on administrative, technical or operational matters.
- First Look: review of the Technical Qualification specification for Providers.
- Getting Ready to Teach: planning, using the support materials, exploring teaching strategies, external and synoptic assessment.

2. Teach

- Regional networks facilitated by our curriculum development managers: sharing good practice and building employer networks to drive innovation and build capacity.
- Industry masterclasses designed and delivered with our EVP: to improve depth of understanding of industry topics.

3. Assess

- Getting Ready to Assess: understanding the standard (using GSEM and mark schemes).

4. Evaluate

- Feedback: examiner feedback and implications for future delivery; demonstrating Exam Wizard and ResultsPlus (see below) to support teaching and exam preparation.

Our events will start in spring 2020 and continue through the contract. To support easy access, the materials will be on our website and events will be delivered in a diverse range of formats:

- face-to-face by a sector specialist
- live online, using interactive technology by a sector specialist
- recorded modules.

Preparing students for external assessment will be new to many tutors. The following two services are unique to Pearson, have proved very popular and will be available for free:

- Exam Wizard is an exam-paper creation tool that allows you to create mock exams and topic tests from a database of sample questions and papers, as well as past papers. Tutors specify the type of assessment they want and a bespoke test with mark scheme and examiner report is created for students to use as practice.
- ResultsPlus is a post-results data analysis tool. It gives item-level analysis by student, class, cohort or cluster of Providers. This allows the user to pinpoint areas of strength and weakness, and to amend teaching and learning to improve student outcomes and motivation.

Provider contact

In addition to the bespoke area of our website which is located [here](#), we will also offer a personal, easy-to-access and expert service via the following:

- Customer Service Account Specialist: named contact for admin/exams officer on administrative or operational matters via phone or email.
- Subject Advisor: named contact for teaching and delivery questions via phone, email, live chat, Facebook, Twitter; provides monthly news promoting support, training and updates.
- Ask the Expert: email address to ask complex or specialist questions relating to content, delivery and assessment.
- Curriculum Development Managers: regional staff who will promote the Technical Qualification, support onboarding and facilitate network events.
- Sector Manager: collect feedback from Providers and employers to identify improvements to our support and services.

Our [T Levels Support](#) webpage gives you all the contact details in order to support you.

This includes our:

7. Pearson Support Portal
8. email addresses for administration and teacher support
9. call centre, which is open between 8am and 5pm
10. postal address.

Appendix 1: Glossary of terms used

This is a summary of the key terms used to define the requirements in the components.

Term	Definition
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.
Complete (diagram)	Complete a diagram or process flow that has already been started.
Calculate	Obtain a numerical answer, showing relevant working if necessary. If the answer has a unit, this must be included.
Complete (table)	Provide the missing information for a table/diagram so that it is complete (contains all the necessary information).
Describe	Present two (or more) linked descriptive points on characteristics, features, uses or processes. Do not need to include a justification or reason.
Discuss	Consider the different aspects in detail of an issue, situation, problem or argument, and how they interrelate.
Draw	Produce a diagram, either using a ruler or using freehand OR create a graphical or visual representation of information.
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.
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.
Give	Recall from memory a feature, characteristic or use.
Identify	Select the correct answer from the given context or stimulus.
Label	Correctly indicate parts of a diagram/image/graphical representation.
List	Recall from memory facts, dates, legal implications, etc. More than one.
State	Recall from memory a fact, date, legal implication, etc.



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