City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma) (2366-03)

Version 1.0 (March 2024)

Qualification Handbook

Qualification at a glance

Subject area	Building Services Engineering (BSE)
City & Guilds number	2366-03
Age group approved	19+ (Adult only)
Entry requirements	Learners should already hold the Level 2 Diploma in Electrical Installations (Buildings and Structures) (2365-02), 8202 or other Awarding Organisation equivalent in order to complete the qualification satisfactorily.
Assessment	Multiple-choice tests Practical assignment Design assignment
Grading	Pass/Fail
Approvals	Full approval required
Support materials	Sample assessments
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates
Occupational Standard(s)	Installation and Maintenance Electrician ST0 152

Title and level	City & Guilds qualification number	Regulatory reference number	GLH	TQT
City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma)	2366-03	610/3899/4	490	581

Version and date	Change detail	Section
0.1 April 2024	Draft version	All

Contents

1 Introduction

What is this qualification about?

Area	Description
Who is the qualification for?	The City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma) is for adults aged 19+ wishing to gain the knowledge, skills and behaviours required for a career within the Electrotechnical sector.
What does the qualification cover?	Learners will acquire a broad body of knowledge, skills and understanding of electrical installation including: • Scientific principles • Inspection, testing and commissioning • Fault finding and diagnosis • Electrical design practices and procedures • Organising and overseeing electrical work activities in buildings • Requirements for electrical installations to BS 7671
What opportunities for progression are there?	The qualification will support progression onto an installation and maintenance electrician apprenticeship. The job outcome once the learner has joined and completed an apprenticeship will be an installation electrician, maintenance electrician and electrician.
Who did we develop the qualification with?	N/A
Is it part of an apprenticeship framework or initiative?	ST0152 Installation and Maintenance Electrician

Content coverage and mapping

Occupational standards

This qualification has been developed to cover as many of the Knowledge, Skills and Behaviours (KSBs) in the relevant occupational standard as it may be reasonable to attain by undertaking a course of education or training. Where KSBs in a relevant occupation standard cannot be reasonably obtained within a course of education or training in an educational setting, City & Guilds seeks the validation from credible employers to ensure that the qualification is fit for purpose.

The knowledge and skills content within this qualification has been amplified to reflect the KSBs. High level mapping to the KSBs in the Apprenticeship standard can be found in the Qualification Structure section. Detailed mapping at topic level can be found in Annex 1 within this qualification handbook.

The table below shows the Occupational Standard the qualification aligns to:

Qualification	Occupational Standard title/Reference
City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma)	Installation and Maintenance Electrician (ST0152)

2 Employer Engagement

City & Guilds would like to take this opportunity to thank all the employers, trade associations, professional bodies, providers, subject matter experts and consultants who have dedicated time to review and validate this qualification. These stakeholders have been used throughout the development and validation of this qualification to ensure the qualification meets the requirements of the occupational standard and the needs of industry. Employer validation recognises the demand or likely demand for learners who have completed the City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma). This collaborative work is to ensure that a learner studying the City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma) has the best opportunities available to them as they progress through their career with a solid base as a starting point.

3 Qualification structure

Structure

To achieve the City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma) (2366-03), learners must achieve:

City & Guilds unit number	Unit title	GLH
Learners must achieve all **six** mandatory units.		
301	Scientific principles	100
302	Inspection, testing and commissioning of electrotechnical systems and equipment	78
303	Fault finding and diagnosis	32
304	Electrical design practices and procedures	170
305	Organising and overseeing electrical work activities in buildings	40
306	Requirements for electrical installations to BS 7671	70

Total Qualification Time (TQT)

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected for a learner to demonstrate the achievement of the level of attainment necessary for the award of a qualification.

TQT comprises of the following two elements:

1) the number of hours that an awarding organisation has assigned to a qualification for guided learning
2) an estimate of the number of hours a learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike guided learning, not under the immediate guidance or supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

Title and level	GLH	TQT
City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma)	490	581

4 Centre requirements

Approval

Full approval

To offer this qualification, new centres will need to gain both centre and qualification approval. Please refer to the document **Centre Approval process: Quality Standards** for further information.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

Resource requirements

Centre staffing

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area(s) for which they are delivering training and/or have experience of providing training (this knowledge must be to the same level as the training being delivered)
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

Assessors

Staff delivering these qualifications are able to take on the role of the assessors in the practical assignment and must still meet the occupational expertise requirements.

Continuing professional development (CPD)

Centres are expected to support their staff in ensuring that their knowledge remains current of the occupational area and of best practice in delivery, mentoring, training, assessment and quality assurance, and that it takes account of any national or legislative developments.

Physical resources

Centres may choose to provide the following resources or require learners to provide certain equipment at their discretion such as hand tools and PPE.

Centres must be able to demonstrate that they have access to the remaining equipment and provide the technical resources required to deliver this qualification and its assessments.

- Test rig (to latest version of City & Guilds Assessor guide for test rig document)
- VDE screwdrivers
- Connector blocks (screw or compression lever)
- Multi-functional test equipment and appropriate leads to BS EN 61557 with manufacturer's instructions (appropriate individual instruments may be used)
- Socket-outlet testers with manufacturer's instructions for all equipment must be available
- Linking/shorting leads (for use when testing)
- Appropriate PPE for each task
- Suitable test rigs to facilitate training and practice (must not be, or directly replicate, any assessment or examination rig)
- Safe isolation test kits (lock and key, label, lock-off device, proving unit and Approved Voltage Indicator).
- Relevant IET publications including BS 7671, On-site Guide and Guidance Note 3.
- Calculators

Quality assurance

Approved centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre approval, qualification approval and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance. All external quality assurance processes reflect the minimum requirements for verified and moderated assessments, as detailed in the Centre Assessment Standards Scrutiny (CASS), section H2 of Ofqual's General Conditions. For more information on both CASS and City and Guilds Quality Assurance processes visit: the What is CASS? and Quality Assurance Standards documents on the City & Guilds website.

Standards and rigorous quality assurance are maintained by the use of:

- internal quality assurance
- City & Guilds external quality assurance.

In order to carry out the quality assurance role, internal quality assurers must:

- have appropriate teaching and vocational knowledge and expertise
- have experience in quality management/internal quality assurance
- hold or be working towards an appropriate teaching/training/assessing qualification
- be familiar with the occupation and technical content covered within the qualification.

External quality assurance for the qualification will be provided by City & Guilds EQA process. EQAs are appointed by City & Guilds to approve centres and to monitor the assessment and

internal quality assurance carried out by centre. External quality assurance is carried out to ensure that assessment is valid and reliable, and that there is good assessment practice in centres.

The role of the EQA is to:

- provide advice and support to centre staff
- ensure the quality and consistency of assessments within and between centres by the use of systematic sampling
- provide feedback to centres and to City & Guilds.

Learner entry requirements

Learners should already hold the Level 2 Diploma in Electrical Installations (Buildings and Structures) (2365-02), 8202 or other Awarding Organisation equivalent in order to complete the qualification satisfactorily.

Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs
- support and guidance they may need when working towards their qualification
- any units they have already completed or credit they have accumulated which is relevant to the qualification
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme, so the learner fully understands the requirements of the qualification, their responsibilities as a learner and the responsibilities of the centre. This information can be recorded on a learning contract.

It is recommended that learners would have Level 2 or equivalent health and safety knowledge related to electrical and maintenance installations.

Age restriction

This qualification is approved for learners aged 19 or above.

Access to assessment and special consideration

For information on how to apply for access arrangements please refer to **Access arrangements: When and how applications need to be made to City & Guilds**.

5 Delivering the qualification

Inclusion and diversity

City & Guilds is committed to improving inclusion and diversity within the way we work and how we deliver our purpose which is to help people and organisations develop the skills they need for growth.

More information and guidance to support centres in supporting inclusion and diversity through the delivery of City & Guilds qualifications can be found here:

Inclusion and diversity | City & Guilds (cityandguilds.com)

Sustainability

City & Guilds are committed to net zero. Our ambition is to reduce our carbon emissions by at least 50% before 2030, and develop environmentally responsible operations to achieve net zero by 2040 or sooner if we can. City & Guilds is committed to supporting qualifications that support our customers to consider sustainability and their environmental footprint.

More information and guidance to support centres in developing sustainable practices through the delivery of City & Guilds qualifications can be found here:

Our Pathway to Net Zero | City & Guilds (cityandguilds.com)

Within this qualification, centres are reminded of their responsibility of supporting sustainable delivery of the qualification and given examples of ways to consider doing so.

Within the qualification content, prospective learners are taught the following content:

- Renewables:
  - Hydro using stored water to drive a turbine
  - Hydro using flowing water, such as a river, to drive a generator
  - Wind turbines driving a rotational generator
  - Large scale solar PV using solar energy to generate electricity through chemical process.
  - Wave and tidal energy
- Energy efficient luminaire types
- Selecting and using equipment considering energy efficiency and sustainability to relevant codes of practice and manufacturer's instructions.

This supports learners having an understanding of the reasons for sustainability in an electrical installation setting, and to underpin key principles and work practices within the scope of their role that would support sustainable practice.

Support materials

The following resources are available for this qualification:

Description	How to access
Sample assessments	www.cityandguilds.com
Qualification handbook	www.cityandguilds.com
SmartScreen	www.smartscreen.co.uk

6 Assessment

Summary of Assessment methods

For City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma), candidates must successfully complete:

Assessment component	Assessment method	Description and conditions
350 Science, design and planning	Externally marked MCQ paper	This assessment covers of units 301, 304 and 305. This '350 Science, design and planning' exam is externally set and externally marked and will be online only. The exam is designed to assess the candidate's depth and breadth of understanding across content in units 301, 304 and 305 (and should only be attempted following learner completion of these units), using multiple choice questions and will be sat under invigilated examination conditions. See JCQ requirements for details: **http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations** The test specification shows the coverage of the assessment across the unit content. Sample assessment materials can be downloaded from the City & Guilds website. Live assessment will be delivered by the City & Guilds online platform E-volve.

Assessment component	Assessment method	Description and conditions
351 Understand inspection, testing and fault finding procedures	Externally marked MCQ paper	This assessment covers units 302 and 305. This '351 Understand inspection, testing and fault finding procedures' exam is externally set and externally marked and will be online only. The exam is designed to assess the candidate's depth and breadth of understanding across content in units 302, and 303 (and should only be attempted following learner completion of these units), using multiple choice questions and will be sat under invigilated examination conditions. See JCQ requirements for details: **http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations** The test specification shows the coverage of the assessment across the unit content. Sample assessment materials can be downloaded from the City & Guilds website. Live assessment will be delivered by the City & Guilds online platform E-volve.

Assessment component	Assessment method	Description and conditions
352 Understand the requirements of electrical installations BS 7671: 2018 (2022)	Externally marked MCQ paper	This assessment covers unit 306. This '352 Understand the Requirements of Electrical Installations BS 7671: 2018 (2022)' exam is externally set and externally marked and will be online only. The exam is designed to assess the candidate's depth and breadth of understanding across content in unit 306 (and should only be attempted following learner completion of these units), using multiple choice questions and will be sat under invigilated examination conditions. See JCQ requirements for details: **http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations** The test specification shows the coverage of the assessment across the unit content. Sample assessment materials can be downloaded from the City & Guilds website. Live assessment will be delivered by the City & Guilds online platform E-volve.

Assessment component	Assessment method	Description and conditions
353 Undertake inspection, testing and fault finding procedures	Internally marked practical assignment	This assessment covers units 302 and 305. The '353 Undertake inspection, testing and fault finding procedures' practical assignment is externally set and internally marked with external verification. The assignment is designed to assess the candidate's depth and breadth of knowledge, skills and understanding from across content in the qualification, at the end of their period of learning, and will be completed under invigilated, controlled assessment conditions. See JCQ requirements for details: http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations The test specification shows the coverage of the assessment across the qualification content. Sample assessment materials can be downloaded from the City & Guilds website. Assignment material availability will be communicated through the publication of a key date schedule.

Assessment component	*Assessment method*	*Description and conditions*
354 Design assignment	Internally marked design assignment	This assessment covers units 301, 302, 304 and 305. The '354 Design assignment' is externally set and internally marked with external verification. The assignment is designed to assess the candidate's depth and breadth of knowledge, skills and understanding from across content in the qualification, at the end of their period of learning, and will be completed under invigilated, controlled assessment conditions. See JCQ requirements for details: http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations The test specification shows the coverage of the assessment across the qualification content. Sample assessment materials can be downloaded from the City & Guilds website. Assignment material availability will be communicated through the publication of a key date schedule.

Scheme of assessment overview

For City & Guilds Level 3 Technical Occupational Entry in Electrical Installations (Diploma) candidates must successfully complete:

Candidates must complete **all** assessment components					
Assessment component	**Method**	**Duration**	**Marks**	**Marking**	**Grading**
350	On demand E-volve online MCQ	2 hours	60	Externally marked	Pass/Fail
351	On demand E-volve online MCQ	1 hour 30 mins	50	Externally marked	Pass/Fail
352	On demand E-volve online MCQ	2 hours	60	Externally marked	Pass/Fail
353	On demand Practical assignment	5 hours	N/A	Internally marked and externally verified	Pass/Fail
354	On demand design assignment	20 hours	N/A	Internally marked and externally verified	Pass/Fail

Candidates must pass all assessment components to achieve the qualification.

Assessment specifications

The assessment specification outlined in the table below highlights at high level the way that the qualification content will be assessed within the **350 Science, design and planning** paper.

Unit	Outcome	Number of Marks	Percentage %
301	LO1 Understand electrical supply systems	5	8
	LO2 Be able to determine how different electrical properties can affect electrical circuits, systems and equipment	7	12
	LO3 Understand the applications of AC motors, DC machines and motor control	3	5
	LO4 Understand the operating principles of electrical components and devices	4	7
	LO6 Understand the principles and applications of electrical heating	1	2
304	LO1 Understand how to prepare for the installation of wiring systems	8	13
	LO2 Understand the applications of wiring systems	8	13
	LO3 Understand the practices and procedures for carrying out electrical work	6	9
	LO4 Understand the characteristics and applications of electrical supply systems and consumers' equipment	5	8
	LO5 Understand earthing and protection	3	5
	LO6 Understand protection against overcurrent	4	7
305	LO1 Understand the requirements for organising and overseeing work programmes	2	4
	LO2 Understand the requirements for working with others when organising and overseeing work activities	3	5
	LO3 Understand the requirements for organising the provision and storage of resources that are required for work activities	1	2
	Total	60	100%

Permitted materials: BS 7671; IET On-site Guide
Non-programmable calculator

Graded: Pass/Fail

Pass mark: the pass mark for this examination is set at approx. 60%

The boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the individual assessment versions be identified.

The assessment specification outlined in the table below highlights at high level the way that the qualification content will be assessed within the **351 Understand inspection, testing and fault finding procedures** paper.

Unit	Outcome	Number of marks	Percentage %
302	LO1 Understand the requirements for completing the safe isolation of electrical circuits and installations	4	8
	LO3 Understand the requirements for completing the initial inspection of electrical installations prior to being placed into service	2	4
	LO4 Understand the requirements for the safe testing and commissioning of electrical installations	3	6
	LO5 Understand the requirements for testing before circuits are energised	6	12
	LO6 Understand the requirements for testing energised installations	8	16
	LO7 Understand the requirements for the completion of electrical installation certificates and associated documentation	6	12
303	LO1 Understand the Health and Safety requirements relevant to fault diagnosis	3	6
	LO2 Understand the importance of reporting and communication in fault diagnosis	4	8
	LO3 Understand the nature and characteristics of electrical faults	5	10
	LO4 Understand fault diagnosis procedures	6	12
	LO5 Understand the procedures for correcting electrical	3	6
	Total	50	100%

Permitted materials: BS 7671; IET On-site Guide
Non-programmable calculator

Graded: Pass/Fail

Pass mark: the pass mark for this examination is set at approx. 60%

The boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the individual assessment versions be identified.

The assessment specification outlined in the table below highlights at high level the way that the qualification content will be assessed within **352 Understand the Requirements of Electrical Installations BS 7671: 2018 (2022)**.

Unit	Outcome	Number of marks	Percentage %
306	LO1 Understand the scope, object and fundamental principles of BS7671.	4	7
	LO2 Understand the definitions used within BS7671.	2	3
	LO3 Understand how to assess the general characteristics of electrical installations.	6	10
	LO4 Understand requirements of protection for safety for electrical installations.	15	25
	LO5 Understand the requirements for selection and erection of equipment for electrical installations.	14	23
	LO6 Understand the requirements of inspection and testing of electrical installations.	4	7
	LO7 Understand the requirements of special installations or locations as identified in BS 7671.	7	12
	LO8 Understand the information contained within Part 8 and the appendices of BS7671.	8	13
	Total	60	100%

Permitted materials: BS 7671; IET On-site Guide
Non-programmable calculator

Graded: Pass/Fail

Pass mark: the pass mark for this examination is set at approx. 60%

The boundaries may be subject to slight variation to ensure fairness should any variations in the difficulty of the individual assessment versions be identified.

Assessment objectives

The following assessment objectives are used within the **350 Science, design and planning** assessment.

The weightings for how the assessment objectives are applied in the assessment are shown in the table below.

Assessment objective	Description	Weighting in Assessment 350
AO1a Demonstrate knowledge of the content	The ability to demonstrate basic recall of relevant knowledge in response to straightforward questioning.	40%
AO1b Demonstrate understanding of the content	The ability to demonstrate understanding of principles and concepts beyond recall of definitions.	50%
AO2 Apply knowledge and understanding of the content to different situations and contexts	Applying knowledge and understanding taking the understanding of generalities and applying them to specific situations.	10%

The following assessment objectives are used within the **351 Understand inspection, testing and fault finding procedures** assessment.

The weightings for how the assessment objectives are applied in the assessment are shown in the table below.

Assessment objective	Description	Weighting in Assessment 351
AO1a Demonstrate knowledge of the content	The ability to demonstrate basic recall of relevant knowledge in response to straightforward questioning.	36%
AO1b Demonstrate understanding of the content	The ability to demonstrate understanding of principles and concepts beyond recall of definitions.	64%
AO2 Apply knowledge and understanding of the content to different situations and contexts	Applying knowledge and understanding taking the understanding of generalities and applying them to specific situations.	N/A

Please note that assessment component **352 Understand the Requirements of Electrical Installations BS 7671: 2018 (2022)** uses command verbs in the assessment criteria, so is not assessed by assessment objectives.

The tables below detail, at high-level, the practical and design assignment coverage

353 Undertake inspection, testing and fault finding procedures

Unit	Learning outcome	Task
302	LO1 Understand the requirements for completing the safe isolation of electrical circuits and installations	1
	LO8 Be able to confirm the safety of electrical systems and equipment prior to inspection, testing and commissioning	1
	LO9 Be able to carry out inspection of electrical installations prior to being placed into service	1
	LO10 Be able to test electrical installations prior to them being placed into service	1
	LO11 Be able to commission electrical systems and equipment	1
303	LO6 Be able to perform fault diagnosis	2

Permitted materials:Permitted materials will be given to candidates by centres.

Graded: Pass/Fail

354 Design assignment

Unit	Learning outcome	Task
301	LO1 Understand electrical supply systems	2
	LO2 Be able to determine how different electrical properties can affect electrical circuits, systems and equipment	2
	LO4 Understand the operating principles of electrical components and devices	2
	LO5 Understand the principles and applications of electrical lighting systems	2
302	LO2 Understand the requirements for initial verification of electrical installations	4
	LO3 Understand the requirements for completing the initial inspection of electrical installations prior to being placed into service	4
	LO4 Understand the requirements for the safe testing and commissioning of electrical installations	4
	LO5 Understand the requirements for testing before circuits are energised	4
	LO6 Understand the requirements for testing energised installations	4

304	LO3 Understand the practices and procedures for carrying out electrical work	3
	LO4 Understand the characteristics and applications of electrical supply systems and consumers' equipment	3
	LO5 Understand earthing and protection	3
	LO6 Understand protection against overcurrent	3
	LO7 Understand electrical systems and circuits	3
	LO8 Be able to apply a cable design procedure	3
305	LO1 Understand the requirements for organising and overseeing work programmes	1
	LO2 Understand the requirements for working with others when organising and overseeing work activities	1
	LO3 3 Understand the requirements for organising the provision and storage of resources that are required for work activities	1

Permitted materials: Permitted materials will be given to candidates by centres.

Graded: Pass/Fail

Availability of assessments

Assignment material availability will be communicated through the publication of a key date schedule. This schedule will include when assignment materials will be released to centres.

All assessments that are on E-volve are on demand and can be booked by the centre when the candidate is ready to be entered for the assessment.

Retakes/Resits

Multiple choice tests

Candidates who have failed an online multiple choice tests assessment are permitted up to four resits of the assessments before re-registration is required.

Assignments

For the practical assignment, candidates who have failed one or more tasks in the assignments, will be advised to complete a further period of learning before resitting the task(s). For Part A, Task 1, candidates must not have two consecutive attempts on the same section of the rig and for Part B, Task 2 candidates must not attempt the same job card pack again.

For the design assignment, where a candidate fails on first submission, they may be allowed one additional attempt to review, rework and re-submit. They may re-work their initial submission materials, but not be given assessor guidance / access to assessor grading notes etc. Where a candidate fails following their second attempt (re-submission) they will be required to complete a further period of learning and must then resit a different version of the assessment.

For both the practical and design assignments, candidates are allowed two resit attempts. before re-registration is required.

Recognition of prior learning (RPL)

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification. RPL can be used to exempt learners from areas of learning previously achieved but does not exempt them from assessment.

RPL is not allowed for this qualification.

7 Units

Structure of the units

These units each have the following:

- City & Guilds reference number
- title
- level
- guided learning hours (GLH)
- unit aim
- assessment type
- learning outcomes, which are comprised of a number of topics
- content
- supporting information
- relationship to /occupational standards inc. reference.

Guidance for delivery of the units

This qualification comprises a number of **units**. A unit describes what is expected of a competent person in particular aspects of their job.

Each **unit** is divided into **learning outcomes** which describe in further detail the knowledge and skills that a candidate should possess.

Each **learning outcome** has a set of **topics** (knowledge or skills) that are simple and concise statements that indicates to a learner something specific they will be learning in relation to the learning outcome. It should provide clarity to a learner at a high level on what they should be expecting to learn or be able to do about a specific area of the learning outcome.

Content (What needs to covered) the content sections define the 'depth and breadth' to which the teaching / learning must be delivered.

It is important that these sections define all the essential content that must be covered for learners to achieve the learning outcome. It is the information in this section that learners will be assessed on.

NB A Glossary can be found in Appendix 2.

Unit 301 Scientific principles

Unit Level:	3
Guided Learning Hours (GLH):	100
Unit Aim:	This unit is designed to enable learners to understand the relationship between electrical scientific principles and the competencies required of a qualified electrical operative. Its content is the knowledge needed by a learner to underpin the application of skills in the installation and maintenance of electrical systems and equipment.
Assessment Method:	Multiple choice question paper Design assignment
Links to Apprenticeship Standard:	Installation and Maintenance Electrician ST0 152 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcome 1

Understand electrical supply systems

Topic	Content What needs to be covered:
1.1 The main methods of generation and the National Grid voltages of electricity used for domestic, industrial and commercial consumption	1.1.1 The basic operating principles and methods of generation: a) Fossil fuels i) Coal fired power stations using steam to drive a turbine ii) Oil fired power stations using steam to drive a turbine. iii) Gas fired power stations using steam to drive a turbine. b) Nuclear power stations using nuclear energy to create steam which drives a turbine. c) Renewables i) Hydro using stored water to drive a turbine ii) Hydro using flowing water, such as a river, to drive a generator iii) Wind turbines driving a rotational generator iv) Large scale solar PV using solar energy to generate electricity through chemical process. v) Wave and tidal energy d) Grid optimisation and demand management i) Pumped storage to drive a turbine at points of high demand. ii) Battery storage to supply electricity to the grid, though an invertor, at points of high demand. 1.1.2 National Grid voltages Voltages used within the UK supply network and in which sections of the grid these are used. a) Typical generation voltage: i) 25 kV b) Transmission voltages: i) 132 kV

	ii) 275 kV iii) 400 kV c) Distribution voltages: i) 230 V ii) 400 V iii) 11 kV iv) 33 kV v) 66 kV vi) 132 kV
1.2-Small scale, localised sources of electricity	1.2.1 The basic operating principles of sources: a) Electrical energy storage systems (EESS) i) A battery is charged and then used to supply an inverter to feed back into the installation when required ii) Flywheel uses electricity to accelerate a rotor, transferring the electrical power into rotational energy and storing it, then the process is reversed to turn the kinetic energy into electrical energy b) Cells/batteries or i) Using chemical reaction to store electrical energy c) UPS systems i) A battery is charged and then used to supply an inverter to feed circuits or equipment in the situation of mains power failure d) Micro hydro i) Hydro using flowing water, such as a river, to drive a generator e) Micro solar i) Using solar energy to generate electricity through chemical process. f) Combined Heat and Power (CHP) i) Using excess heat from heating systems to generate electricity

	g) Electric vehicle systems (vehicle to grid) h) Using the batteries within the electrical vehicle to back feed by an inverter into the installation
1.3 The types of supply system used in the low-voltage public distribution network	1.3.1 The voltages and conductor arrangements, of supply systems: a) Single-phase electrical supplies i) Line to neutral at 230 V (U_0) b) Three-phase and neutral supplies i) Line to neutral at 230 V (U_0) ii) Line to line at 400 V (U)
1.4 Operating principles, applications, and limitations of transformers	1.4.1 Operating principles and typical uses for different types of transformer: a) Autotransformer i) Single winding with a tap-off point used for variable outputs and where electrical separation is not required b) Current i) Measures the magnetic field around a conductor used to determine the current within the cable c) Isolation i) Two or more coils used to transfer electrical energy by means of a changing magnetic field used to provide • different input to output voltages • 1:1 for electrical separation for shock protection d) Voltage i) Measures the magnetic field around a conductor used to determine the voltage within the cable 1.4.2 Operating principles of power transformers: a) Transformer core operating principle i) using its ferrous properties to transfer electrical energy into magnetic field and back into electrical energy b) Mutual induction between windings

c) Relationship between current and voltage in different transformer arrangements
d) Primary and secondary windings and the relationship between them
e) Determination of EMF produced
f) Number of turns per winding and how these relate to voltage

1.4.3 Typical applications for each type of power transformer:

a) Where used to step-up voltages
   i) For increasing voltages in the distribution network
   ii) Powering high-voltage lighting
b) Where used to step-down voltages
   i) For decreasing voltages in the distribution network
   ii) Used for reducing voltage in electrical equipment
c) Where used for electrical separation
   i) For shaver sockets
   ii) For reduced low-voltage construction site supplies

1.4.4 Limitations causing loss of energy:

a) Iron losses
b) Eddy currents
c) Hysteresis losses
d) Copper losses
e) Winding losses

Learning outcome 2

Be able to determine how different electrical properties can affect electrical circuits, systems and equipment

Topic	Content What needs to be covered:
2.1 Calculate transformer values	2.1.1 Values: a) Primary and secondary turns b) Primary and secondary voltages where only one is known c) Primary and secondary currents where only one is known d) Ratio of windings to achieve required voltage e) Ratio of currents between primary and secondary windings f) kVA ratings
2.2 Types of power factor	2.2.1 What causes the different types of power factor leading and lagging: a) Current leading voltage in capacitive circuits b) Current lagging voltage in inductive circuits c) Unity
2.3 Calculate values in AC circuits	2.3.1 Values: a) Resistance b) Impedance c) Reactance i) Capacitive ii) Inductive d) Power factor 2.3.2 AC circuits: a) Series and parallel circuit arrangements b) RLC circuits
2.4 Show the relationship between power quantities	Use of both calculations or scaled power triangle drawing to establish any of the values in the range. 2.4.1 Power quantities: a) Apparent power

	i) kVA. b) True power i) kW. c) Reactive power i) $kVA_{r.}$
2.5 Methods of power factor correction	Where and how power factor correction can be improved. 2.5.1 Power factor: a) Use of capacitors in parallel with the load b) Use of capacitor banks at the origin of supply connected in parallel c) Synchronous condensers
2.6 Calculate the neutral current in three-phase and neutral systems	2.6.1 Systems: a) Balanced, where the current in each line is equal b) Unbalanced, where the current in each line is unequal
2.7 Calculate values in both star and delta connected systems	2.7.1 Values: a) Voltage i) Phase voltage Vp ii) Line voltage Vl b) Current i) Phase current I_p ii) Line current Il c) Power

Learning outcome 3

Understand the applications of AC motors, DC machines and motor control

Topic	Content What needs to be covered:
3.1 Types of AC motor	3.1.1 Types of AC motor: a) Single-phase i) Universal motor ii) Split-phase motor iii) Capacitor start motor iv) Capacitor start /capacitor run motor v) Shaded pole motor b) Three-phase i) Cage-type induction ii) Wound rotor induction iii) Synchronous
3.2 Types of DC motor	3.2.1 Types of DC motor: a) Series b) Shunt c) Long compound d) Short compound
3.3 The features of motor control	3.3.1 Motor control: a) Direct-on-line i) Single or three-phase ii) No speed control b) Star-Delta starters i) Three-phase ii) Reduce current on start-up c) Rotor-resistance i) Three-phase ii) Variable resistance to the rotor windings d) Soft-start i) Single or three-phase ii) Reduced voltage on start-up

	e) Variable frequency i) Single or three-phase ii) Speed control iii) Torque control

Learning outcome 4

Understand the operating principles of electrical components and protective devices

Topic	Content What needs to be covered:
4.1 The operating principles of electrical components used for circuit control	4.1.1 Typical uses of electrical components used for circuit control: a) Contactors i) Motor control b) Solenoids i) Gas shut-off valves in emergency situations c) Relays i) Control of supplies by electronic circuits. d) Thermal overload trips i) Overload protection e) Emergency stop switches i) To remove unexpected danger 4.1.2 Operating principles a) Control coils within contactors, solenoids and relays producing magnetic fields when energised b) A contact (hold-on) to maintain the supply to a contactor's magnetic coil once energised c) Emergency switches opening a control circuit to de-energise a contactor d) Normally open contact arrangements of contactors and relays e) Normally closed contact arrangements of contactors and relays f) Thermal overload trips de-energising contactor coil in the event of an overload

4.2 Types and operating principles of protective devices	4.2.1 Protective devices: a) HRC fuses to BS 88 b) Cartridge fuses to BS 1362 c) Re-wireable fuses to BS 3036 d) Circuit-breakers to BS 60898 and BS 60947-2 e) RCBOs to BS EN 61009 f) RCDs to BS 61008 g) AFDDs h) SPDs 4.2.2 Operating principles of relevant devices in relation to: a) Bi-metallic strip heating up due to excess current operating the device b) Solenoid requiring a certain amount of current to achieve a magnetic strength required to operate the device c) A magnetic core monitoring the line(s) and neutral currents of a circuit in order to detect any loss of current d) A processor chip monitoring wave form signatures in order to detect arcing within circuits e) When a transient voltage occurs, a Surge Protection Device (SPD) limits the transient voltage and diverts the current f) When an overcurrent occurs the element melts/ruptures 4.2.3 Characteristics of overcurrent protective devices (inc. RCBOs) a) Rated current or current setting b) Operational characteristics during overload conditions i) May take several hours to operate c) Operational characteristics during Earth fault or short circuit conditions i) Large current required to operating in a short space of time

4.2.4 Characteristics of RCDs (inc. RCBOs)

a) Operational characteristics during Earth fault conditions

i)Very low residual current needed to operate

Learning outcome 5

Understand the principles and applications of electrical lighting systems

Topic	Content What needs to be covered:
5.1 The principles of illumination and illumination laws.	5.1.1 Principles a) Luminous intensity b) Luminous flux c) Illuminance d) Efficacy e) Maintenance factor f) Coefficient of utilisation g) Space-height ratio h) colour temperature i) beam angle (physical angle of fitting, or manufacturer creating a wide or narrow beam) 5.1.2 Laws of illumination used for calculations a) Inverse square law a) Cosine law b) Lumen method
5.2 The types, controls and connections of luminaires	5.2.1 Typical legacy luminaires used for retrofit: a) General Lighting Service (GLS) tungsten filament i) Tungsten ii) Halogen iii) PAR30 a) Discharge lighting i) Low- and high-pressure mercury vapour ii) Low- and high-pressure sodium vapour iii) Metal halide 5.2.2 Typical energy efficient luminaires: a) LED, including different colour temperatures

	i) Flood lighting ii) Bayonet and Eddison screw lamps iii) Spot lights iv) Hi-bay lamps v) Strip lighting 5.2.3 Luminaire controls and connections a) Dimmer types and fine-tune settings (where applicable) b) Cap/connection for different lamp types c) Lamp driver/power supply types

Learning outcome 6

Understand the principles and applications of electrical heating

Topic	Content What needs to be covered:
6.1 The principles of heat transfer and different types of electrical heating to heat space and water	6.1.1 Basic operation principles and typical uses of space heating: a) Underfloor heating i) Current through a high resistance element b) Storage heaters i) Typically uses off peak tariff to store heat in dense bricks c) Panel heaters i) Current through a high resistance element d) Radiant heaters i) use of infrared to heat bodies rather than space e) Heat pumps i) Ground source: Extracts heat from the ground and compresses it to amplify it ii) Air source: Extracts heat from the air and compresses it to amplify it

	6.1.2 Basic operation principles and typical uses of water heating systems: a) Immersion heater systems i) Current through a high resistance element to heat a cylinder of water slowly b) Instantaneous water heaters i) Current through a high resistance element to heat the water quickly 6.1.3 Heat transfer principles for space heater and water heating systems: a) Conduction b) Convection c) Radiation
6.2 The types of central heating control systems, the components and how they operate	6.2.1 Wiring arrangement for central heating control systems: a) S-plan b) Y-plan c) S-plan+ 6.2.2 Central heating components: a) Use of programmers to control the operating periods of the heating: i) Timers ii) Internet enabled control systems. b) Use of motorised valve to control which parts of a system are being heated: i) 2-port valve ii) 3-port valve c) Use of thermostat to control temperature: i) Overall heating system ii) Individual room iii) Hot water cylinder d) Use and location of circulation pump used to move water around the heating system: i) Within the heating boiler ii) External to the heating boiler e) Use of fused connection units for supplies to heating systems

Guidance for delivery

Tips for tutors on how the unit may be delivered in an engaging way including:

- This unit could be delivered alongside Unit 4 Electrical design practices and procedures
- Opportunities for visits/engagement with local industry and employers would be beneficial for learners, such as manufacturers of cable, protective device, isolators and switches, solar panels and electric vehicle chargers

NB – Content included in this section cannot be assessed.

Suggested learning resources

Books

BS 7671 - IET Wiring Regulations (Latest edition)

Electrical Installations Book 2, Peter Tanner, second edition, City & Guilds, 2019

Websites

www.iet.org/BS7671 : The Institute of Engineering and Technology

Unit 302 Inspection, Testing and Commissioning of Electrotechnical Systems and Equipment

Unit Level:	3
Guided Learning Hours (GLH):	78
Unit Aim:	The aim of this unit is to enable learners to understand principles, practices and legislation for the initial verification of electrical installations. Learners will gain an understanding of the safe testing and commissioning of electrical installations and the requirements for completing electrical installation certificates and associated documentation. Learners will also develop the skills needed to carry out inspection and testing of electrical installations prior to being placed into service and commission electrical systems and equipment and reporting of electrical installations, including the condition of existing systems.
Assessment Method:	Multiple choice question paper Practical assignment Design assignment
Links to Apprenticeship Standard:	Installation and Maintenance Electrician ST0 152 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcome 1

Understand the requirements for completing the safe isolation of electrical circuits and installations

Topic	Content What needs to be covered:
1.1 The requirements of the Electricity at Work Regulations for the safe inspection of electrical systems and equipment	How the relevant Electricity at Work Regulations apply during inspection and testing work 1.1.1 Electricity at Work Regulations: a) Regulation 4 Systems, work activities and protective equipment b) Regulation 5 Strength and capability of electrical systems equipment c) Regulation 13 Precautions for work on equipment made dead d) Regulation 14 Work on or near live conductors e) Regulation 15 Working space, access and lighting f) Regulation 16 Persons to be competent to prevent danger and injury
1.2 The appropriate procedure for completing safe isolation in accordance with regulatory requirements	1.2.1 Factors that could influence the safe isolation procedure: a) Safe working practices b) Selecting correct test and proving instruments in accordance with relevant industry guidance and standards c) Appropriate sequence for isolating circuits d) Following risk assessments e) Preparing method statements f) Following permits to work 1.2.2 Procedure: a) Obtain permission to start work (a Permit may be required in some situations) b) Identify the source(s) of supply using an approved voltage indicator or test lamp

	c) Prove that the approved voltage indicator or test lamp is functioning correctly d) Isolate the supply(s) e) Secure the isolation with an appropriate device f) Prove the system/equipment is DEAD using an approved voltage indicator or test lamp g) Prove that the approved voltage indicator or test lamp is functioning correctly h) Put up warning signs to tell other people that the electrical installation has been isolated i) Once the system/equipment is proved DEAD, work can begin
1.3 The reasons for carrying out safe isolation when working on electrical installations	1.3.1 Reasons**:** a) Reduce the risk of electric shock b) Ensure the safety of relevant persons i) The inspector ii) Other personnel iii) Customers/clients iv) Public c) Ensure the safety of systems which may be accidentally energised otherwise.
1.4 The issues which may need to be mitigated when carrying out safe isolation	1.4.1 Potential issues to consider dependant on location and circumstance: a) Loss of power to small power and lighting circuits b) Loss of power to essential systems i) Lifts ii) Heating c) Loss of power to critical systems i) Medical oxygen ii) Medical drips iii) Life support systems d) Loss of power to alarm systems i) Fire alarm ii) Nurse's call iii) Gas detection systems e) Loss of power to IT systems f) Loss of power to emergency lighting systems

1.5 The health and safety requirements and unsafe situations which may arise if these are not complied with	1.5.1 Health and Safety requirements which apply when inspecting and testing: a) Safe systems of work: i) Preparation and following of risk assessments ii) Preparation and following of method statements iii) Following permit to work systems b) Tools and equipment: i) Proving unit to check voltage indicator functionality ii) Approved voltage indicators for safe isolation iii) Lock off kit for use during safe isolation. iv) Use of VDE tools as appropriate to task v) Use of test instruments and leads conforming to GS38 c) PPE i) Goggles ii) Light eye protection iii) Gloves and gauntlets d) Unsafe situations: i) Lack of access to isolation equipment ii) Incorrect identification of isolation device e) Detection of possible diverted neutral currents prior to disconnection of earthing or bonding conductors:21 i) Methods for testing for diverted neutral current ii) Potential shock risk if disconnected with current present iii) Potential arc risk if disconnected with current present

Learning outcome 2

Understand the requirements for initial verification of electrical installations

Topic	Content What needs to be covered:
2.1 The requirements of the initial verification of electrical installations in compliance with BS 7671	2.1.1 Requirements of the verification process: a) Installation is safe to be put into service b) No part of the installation has been damaged or is defective
2.2 The relevant documents associated with the inspection, testing, commissioning and reporting of an electrical installation	The purpose of the documents and how they aid and guide inspection, testing and commissioning procedures 2.2.1 Relevant documents: a) Electricity at Work Regulations b) BS 7671 c) IET Guidance Note 3 d) On-site Guide e) HSE Guidance f) Manufacturer's instructions 2.2.2 Inspection a) Initial verification b) Periodic Inspection, including sampling, i) extent and limitations, ii) condition report codes iii) situations requiring reporting
2.3 The information required by the inspector to conduct the initial verification of an electrical installation	2.3.1 Information required prior to carrying out an initial verification and appropriate ways to obtain this: a) Maximum demand and diversity figures from the installation designer b) Conductor system and earthing arrangements for the installation c) Nominal voltage, current, frequency, prospective fault current and external earth fault loop impedance

	d) Compatibility of characteristics as per Part 3 of BS 7671 e) Diagrams, documents, plans and design criteria of the building

Learning outcome 3

Understand the requirements for completing the initial inspection of electrical installations prior to being placed into service

Topic	Content What needs to be covered:
3.1 Items to be checked during the inspection process	3.1.1 Items to be checked during initial verification: a) Relevant items as listed on the electrical installation certificate (EIC) b) Schedule of inspections as per BS 7671
3.2 How human senses can be used during the inspection process	3.2.1 Human senses to be used during the initial verification process to check any possible non-compliance issues: a) Touch i) Item are securely fixed ii) Secure connections of terminations iii) Removal of sharp edges b) Smell i) Signs of overheating ii) Loose connections under load conditions c) Hearing i) Sign of arcing ii) Equipment malfunction noise d) Sight i) Correct identification of conductors ii) Labelling iii) Correct connection of accessories iv) Routing of cables v) IP ratings

3.3 Reasons items are checked during the inspection of electrical installations	3.3.1 Reasons: a) To check the installation is safe to be put into service b) To check the installation is compliant with BS 7671 c) To check the installation meets client specification d) To check equipment is compliant with manufacturer's instructions

Learning outcome 4

Understand the requirements for the safe testing and commissioning of electrical installations

Topic	Content What needs to be covered:
4.1 The reasons why testing is carried out in the relevant sequence specified in BS 7671 and IET Guidance Note 3	4.1.1 Reasons a) Safety b) Ensure validity of previous tests 4.1.2 Sequence, as given in BS 7671, is to be followed during initial verification tests: a) Continuity of protective conductors b) Continuity of ring final circuit conductors c) Insulation resistance d) Circuit polarity e) Earth electrode resistance f) Polarity of supply g) Earth fault loop impedance h) Prospective fault currents (PFC) i) I_{PSCC} ii) I_{PEFC} i) Residual current devices (RCD / RCBO) j) Phase sequence (where applicable) k) Functional testing

4.2 The appropriate test instrument and settings to be used during the inspection and testing process for accurate results	4.2.1 Appropriate test instruments: a) Low-resistance ohmmeter b) Insulation resistance tester c) Earth fault loop impedance tester d) Residual current device (RCD) tester e) Prospective fault current (PFC) tester f) Earth electrode resistance tester g) Phase-rotation tester 4.2.2 Appropriate setting for each test and units of measurement: a) Megohms MΩ (unit of measurement for IR tests) b) Ohms Ω (setting and unit of measurement for continuity, earth electrode resistance testing and EFLI tests) c) Milliseconds ms (unit of measurement for RCD tests) d) PFC (setting for PFC tests) e) Kiloamps kA (unit of measurement for PFC tests) f) Voltage V (setting for IR tests, 250 V and 500 V)
4.3 The requirements for the safe and correct use of instruments for testing and commissioning	4.3.1 Requirements for safe and correct use of test instruments (as listed in 4.2.1): a) Instrument accuracy b) Calibration c) Equipment functionality d) Familiarity and/or training with equipment to ensure safe usage. e) Test lead checks to identify any breaks in insulation and/or exposed and assessable metal 4.3.2 Pre-test checks to be carried out with regards to safe use: a) Checks required to prove that test instruments are safe and unbroken

	b) The requirements for test leads and probes must comply with HSE Guidance GS38 as applicable i) Maximum exposed tip 4 mm ii) recommended exposed tip 2 mm c) The need for instruments to be checked before each use
4.4 The reasons why it is necessary for test results to conform to standard values in the design, guidance, and BS 7671	4.4.1 Reasons: a) To ensure, as much as practicable, the safety of persons, livestock and property against dangers and damage which may arise in the reasonable use of the electrical installation. b) To ensure the installation has been completed in accordance with the design c) To ensure the installation conforms to the requirements of BS 7671
4.5 The actions to be taken in the event of unsatisfactory results being obtained	4.5.1 Actions: a) Persons who could need to be informed of unsatisfactory inspection and/or test results in order to get these rectified before certification. i) Main contractor ii) Designer iii) Line manager iv) User v) Client b) Permissions potentially required before rectification work can commence. i) Variation order ii) Instruction to proceed c) Potential issues that could arise with regard to getting access to undertake remedial action and/or repairs i) Site, or part thereof, not being accessible ii) Working hour restrictions at the site iii) Cables and/or containment systems being within the fabric of the building d) Carrying out of remedial works

	e) The necessity to re-inspect and/or re-test after any remedial action to ensure the installation now conforms to BS 7671

Learning outcome 5

Understand the requirements for testing before circuits are energised

Topic	Content What needs to be covered:
5.1 The reasons why it is necessary to verify continuity of protective and ring final circuit conductors within electrical installations	5.1.1 Reasons for verifying continuity of protective and ring final circuit conductors: a) To ensure protective bonding conductors, where applicable, are continuous and form a connection to all extraneous-conductive-parts within the installation b) To confirm all exposed-conductive-parts are connected to the earthing system via one or more circuit protective conductors c) To obtain the value of R_2 or (R_1+R_2) for each radial circuit d) To confirm polarity in radial circuits e) To identify if a ring final circuit is correctly formed with interconnections or spurs from spurs. f) To obtain the value of (R_1+R_2) for the ring circuit g) To confirm polarity in ring final circuits 5.1.2 Verifying continuity of: a) Protective bonding conductors (where applicable) b) Circuit protective conductors c) Ring final circuit conductors (where applicable)

5.2 The methods for verifying continuity within an electrical installation	5.2.1 Methods: a) Visual inspection of fully accessible bonding conductors b) (R_1+R_2) test using line and cpc connected together c) (R_2) test using a long or 'wandering lead' d) Ring final circuit continuity test as described in the On site Guide
5.3 The factors that affect conductor resistance test values	How additional or outside factors can affect conductor resistance test values 5.3.1 Factors: a) Cables connected in parallel with the tested conductor b) Variations in cable length of the tested conductor c) Variations in conductor cross-sectional area d) Temperature: i) Conductors at ambient temperature having a lower resistance than when the conductors are carrying a load ii) Conductors at operating temperature having a higher resistance than when at ambient temperature
5.4 The procedures for completing insulation resistance testing	5.4.1 Procedures: a) Preparation i) Precautions to be taken before conducting insulation resistance tests as given in the On site Guide including: • Ensuring the connection of all circuit protective and bonding conductors to the MET within the installation • Identifying typical voltage sensitive devices including dimmer switches, electronic controls and smoke alarms. • Presence of surge protective devices b) Health and safety considerations i) Cable storing charge due to capacitance ii) GS38 Standard for test leads (see HSE guidance GS38) c) Test methods

	i) Methods of testing insulation resistance as described in the On site Guide ii) The required test voltages and minimum insulation resistance values for circuits and installations operating at various voltages within the definitions of ELV and LV as given in Part 6 of BS 7671 iii) Particular requirements for testing where there are voltage sensitive devices and/or surge protection devices installed On site Guide
5.5 The effects of installed cables on insulation resistance values	5.5.1 Variation of insulation resistance test values: a) Variations in insulation resistance test values where circuits are tested individually as opposed to being connected to multiple circuits. b) Variations in insulation resistance of circuits in proportion to cable length (insulation resistance decreases as circuit length increases).
5.6 Reasons for single-pole devices, centre screw lamps and electrical accessories need to have correct polarity verified	5.6.1 Reasons for needing correct polarity verification: a) All single-pole devices, including light switches, fuses and circuit breakers, are connected in the line conductor b) All centre-contact lamp holders have the outer threaded contact connected to the neutral. Not to include: E14 & E27 lamp holders to BS EN 60238 c) All electrical accessories, including socket-outlets and fuse connection units, are correctly connected
5.7 The procedures for verifying circuit conductor polarity	5.7.1 Procedure: a) (R_1+R_2) method connecting line to cpc and testing at all relevant points within the circuit b) Wander lead method testing each conductor end-to-end c) Visually verifying that each conductor is connected to the right point

5.8 The method for measuring earth electrode resistance of supply electrodes and within installations	5.8.1 Method: a) Using a dedicated earth electrode resistance tester (procedures as given in the On site Guide) 5.8.2 Installations: a) Utilizing a TT earthing system b) Generators c) Supply Transformers It needs to be explained to learners why a value exceeding 200 Ω may not be stable including variance of ground resistance due to freezing and thawing and between wet and dry ground.

Learning outcome 6

Understand the requirements for testing energised circuits.

Topic	Content What needs to be covered:
6.1 The procedures for verifying correct polarity of the incoming supply	6.1.1 Procedures: a) Voltage indicator test i) at main switch b) Visual inspection c) Earth fault loop impedance tester whilst carrying out Z_e test
6.2 The test for measuring earth electrode resistance in an energised installation	6.2.1 Test: a) Z_e test using an earth fault loop impedance tester (for TT installations procedure as given in the On site Guide) 6.2.2 Installation a) Part of a TT installations
6.3 The common earth fault loop paths	6.3.1 Common earth fault loop impedance paths (as given in Part 3 of BS 7671): a) TT b) TN-S c) TN-C-S
6.4 The methods for verifying protection by automatic disconnection of supply	6.4.1 Methods: a) Calculation of the value of Zs from given information [$Z_s = Z_e + (R_1+R_2)$] b) Direct live measurement of the earth fault loop impedance (Z_s) c) Establishing Z_e by enquiry from the DNO to establish earth fault impedance (this must include specific confirmation from the DNO, not a generic maximum value) d) Comparing measured Z_s values with: i) The maximum tabulated values as specified in BS 7671 including the

	application of the correction factor as given in Appendix 3 of BS 7671. ii) The maximum measured values as given in Guidance Note 3 and the On-site Guide, which include allowance for operating temperature increase of resistance.
6.5 The methods for determining prospective fault current in installations	6.5.1 Methods (as described in the On-site Guide): a) Direct live measurement of I_{PSCC} & I_{PEFC} with a PFC tester b) Calculation of I_{PSCC} & I_{PEFC} using impedance figures c) Enquiry to the supplier 6.5.2 Determining prospective fault current: a) On single-phase installations test between line and neutral and between line and Earth b) On three-phase installations test between line and line and between line and Earth. Alternatively, line and line can be approximated from line to neutral times 2.
6.6 The suitability of protective devices for prospective fault currents	6.6.1 Protective devices (figures to be taken from the On site Guide or manufacturer's labelling and/or instruction): a) Semi enclosed fuses BS 3036 b) Cartridge fuses BS 1361 c) HRC fuses BS 88 d) Circuit breakers BS EN 60898 e) RCBOs BS EN 61009
6.7 The tests for the correct operation of residual current devices (RCD)	6.7.1 Tests required by BS 7671 (as per description in the On-site Guide) a) Manual test button b) Test at 0.5 x $I_{\Delta n}$ c) Test at 1 x $I_{\Delta n}$ Optional tests (as per description in the On site Guide) a) Test at 5 x $I_{\Delta n}$ b) Ramp test

6.8 The procedure for verifying phase sequence and the potential consequence of incorrect sequence	6.8.1 Procedure for confirming phase sequence (as described in the On site Guide) a) Using a phase sequence tester at the origin of the installation b) Using a phase sequence at sub-distribution boards c) Using a phase sequence tester at equipment controllers/isolators 6.8.2 Reasons for carrying out a phase sequence check a) Three-phase motors within machines/equipment will rotate in the correct direction
6.9 The items which require functional testing/checking when installed and the testing methods used	6.9.1 Items that would require functional testing/checking when installed and the methods used: a) Protective devices and testing method used i) RCDs by pressing the test button ii) RCBOs by pressing the test button iii) AFDDs by pressing the test button iv) Circuit-breakers by switching on and off b) Switchgear and controls and testing method used i) Isolators by switching on and off ii) Control switches by switching on and off iii) Interlocks by checking correct functionality as appropriate iv) Motor Control by checking correct functionality as appropriate v) Timers and heating controllers by checking correct functionality as appropriate vi) PIR and photocells sensors (for lighting) by checking correct functionality as appropriate c) Connected equipment and testing method used

	i) Sockets-outlets using a socket-tester and checking switch, if included, operates correctly ii) Luminaires by checking correct functionality as appropriate iii) Water heater by checking they heat to the desired temperature (and not above) iv) Electric heaters/heating systems by checking operation in line with manufacture's instructions

Learning outcome 7

Understand the requirements for the completion of documentation

Topic	Content What needs to be covered:
7.1 The reasons for issuing certification and documentation	7.1.1 Types of certification/documentation a) An Electrical Installation Certificate i) Generic Schedule of Circuit Details ii) Generic Schedule of Test results b) A Minor Electrical Installation Works Certificate (only for minor work which does not include the provision of a new circuit) c) Electrical Installation Condition Report d) Condition Report Inspection Schedule 7.1.2 Reasons for issuing electrical documentation: a) For a new installation b) For additions to an existing installation c) For alterations to an existing installation d) For periodic inspection and testing of an existing installation e) To prove compliance with BS 7671 (which may be required in future should anything go wrong) f) To prove compliance with insurance company requirements g) To be used for reference for future work

	h) To be used as part of a documented maintenance routine i) To aid fault rectification if future problems arise
7.2 The information that must be contained on inspection and testing certification/ documentation	7.2.1 Information (as per model forms in Appendix 6 of BS 7671): a) Serial numbers of test equipment b) Details of signatories c) Details of client d) Installation address e) Description/extent of installation f) Next inspection date g) Supply characteristic/earthing arrangements h) Test results i) Schedule of inspections j) Circuit details 7.2.2 Inspection and testing certification/documentation a) An Electrical Installation Certificate i) Generic Schedule of Circuit Details ii) Generic Schedule of Test results b) A Minor Electrical Installation Works Certificate (only for minor work which does not include the provision of a new circuit) c) Electrical Installation Condition Report d) Condition Report Inspection Schedule
7.3 The requirements for the retention of completed inspection and testing certification/ documentation	7.3.1 Persons and organisations requiring copies of certification and the reasons these need to be retained: a) Person required to receive original certification i) Client b) Persons/organisations that may require to receive copies of certification i) Property tenant/occupier ii) Local Authority building control iii) Insurance company iv) Licensing Authority v) Competent Person Scheme c) Reasons for retention

	i) Insurance purposes ii) Change of tenant iii) Change of use iv) After fire damage
7.4 The roles and responsibilities of different relevant personnel in relation to the completion of the Electrical Installation Certificate	7.4.1 Roles: a) Designer b) Installer c) Inspector and tester 7.4.2 Responsibilities a) Designer: responsible for recommending the interval that further inspection and testing is required b) Installer: responsible for the construction of the installation c) Inspector/tester: responsible for carrying out the initial verification

Learning outcome 8

Be able to confirm the safety of electrical systems and equipment prior to inspection, testing and commissioning

Topic	**Content** What needs to be covered:
8.1 Comply with the health and safety requirements during the initial verification process	8.1.1 Requirements to make the initial verification process safe: a) Ensuring the safety of others during the work activities b) Keeping clients and those present in the building informed during the process c) Safe use of appropriate tools and equipment d) Safe and correct use of measuring instruments e) Use of appropriate PPE f) Reporting of unsafe situations
8.2 Carry out safe isolation procedures	8.2.1 Procedure: a) Obtain permission to start work (a Permit may be required in some situations)

	b) Identify the source(s) of supply using an approved voltage indicator or test lamp c) Prove that the approved voltage indicator or test lamp is functioning correctly d) Isolate the supply(s) e) Secure the isolation f) Prove the system/equipment is DEAD using an approved voltage indicator or test lamp g) Prove that the approved voltage indicator or test lamp is functioning correctly h) Put up warning signs to tell other people that the electrical installation has been isolated i) Once the system/equipment is proved DEAD, work can begin

Learning outcome 9

Be able to carry out inspection of electrical installations prior to being placed into service

Topic	**Content** What needs to be covered:
9.1 Carry out an initial inspection of an electrical installation in accordance with the requirements of BS 7671 and IET Guidance Note 3	9.1.1 Requirements: a) Relevant items as listed on the electrical installation certificate (EIC)
9.2 Complete a Schedule of Inspections in accordance with BS 7671 and IET Guidance Note 3	9.2.1 Schedule of Inspections: a) Relevant section on the EIC

Learning outcome 10

Be able to test electrical installations prior to them being placed into service

Topic	Content What needs to be covered:
10.1 Select the test instruments/scale and accessories for carrying out testing	Instruments to be selected 10.1.1 Instruments/scale: a) Continuity: ohms b) Insulation resistance: meg-ohms c) Polarity: ohms for dead test/voltage for live test d) Earth fault loop impedance: ohms e) Prospective fault current: kA f) RCD operation: ms 10.1.2 Test instrument accessories: a) Test leads b) Test probes c) Test adapters d) Test clips
10.2 Carry out appropriate tests on an electrical installation	10.2.1 Tests on an electrical installation in accordance with BS 7671, IET On-site Guide and Guidance Note 3 procedures: a) Continuity of protective conductors and ring final conductor b) Insulation resistance c) Polarity d) External earth fault loop impedance (Ze) e) System earth fault loop impedance (Zs) f) Prospective fault current g) RCD operation h) Functional testing
10.3 Evaluate test results to verify they comply with values given in approved publications	10.3.1 Publications to reference when confirming if test results are acceptable: a) BS 7671 b) IET On-site Guide

	c) Guidance Note 3
10.4 Complete appropriate documentation	10.4.1 Documentation to be completed as per Appendix 6 of BS 7671: a) An Electrical Installation Certificate b) Generic Schedule of Circuit Details. c) Generic Schedule of Test results.

Learning outcome 11

Be able to commission electrical systems and equipment

Topic	Content What needs to be covered:
11.1 Clarify the commissioning procedure with relevant persons	11.1.1 Commissioning procedure: a) Issuing of documentation b) User functional checks c) Recommended retest date
11.2 Carry out functional testing on accessories and equipment	11.2.1 Accessories and equipment to be functionally tested: a) Switches b) Socket-outlets c) Luminaires d) Motor e) Fan f) Protective devices g) Isolators h) Motor control i) Connected equipment

Guidance for delivery

Tips for tutors on how the unit may be delivered in an engaging way including:

- For topic 11.1, in this context the relevant person is the assessor.
- The learning outcomes of this unit complements the learning required for Unit 3 Fault Finding and Diagnosis. Therefore Unit 3 Fault Finding and Diagnosis naturally flows after Unit 2.
- Sample question papers and practical simulated Inspection and testing tasks would serve as formative assessment opportunities.
- Site visits to engage with local employers where inspection and testing is taking place would be advantageous.
- Where appropriate, inspection of training providers own supply intake to complement learning around earthing systems. links to inspection and testing videos to reinforce testing methods, interactive inspection and testing apps are some innovative methods to supplement delivery and reinforce learning.
- Training providers should ensure they are using the current amended editions of:, Guidance Note 3 (GN3), and the On-site Guide (OSG).

Suggested learning resources

Books

BS 7671 IET Wiring Requirements (latest edition)

Guidance Note 3: Inspection & Testing, 9th Edition, IET, 2022, ISBN-13: 978-1-83953-236-8

The On-Site Guide (BS 7671:2018+A2:2022), 8th Edition, IET, 2022, ISBN-13: 978-1-83953-227-6.

Websites

https://electrical.theiet.org/bs-7671/

https://electrical.theiet.org/courses-resources-career/free-resources/videos/

https://www.netservices.org.uk/test-app/

Unit 303 Fault finding and diagnosis

Unit Level:	3
Guided Learning Hours (GLH):	32
Unit Aim:	The aim of this unit is to enable learners to understand fault finding and diagnosis. Learners will gain an understanding of the legislative and health and safety requirements, along with the understanding required for reporting and communicating relevant information to relevant personnel. Learners will also gain the skills to undertake fault diagnosis safely and effectively.
Assessment Method:	Multiple choice question paper Practical assignment
Links to Apprenticeship Standard:	Installation and Maintenance Electrician ST0 152 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcome 1

Understand the health and safety requirements relevant to fault diagnosis

Topic	Content What needs to be covered:
1.1 The risks associated with electricity in relation to fault diagnosis work	1.1.1 Risks associated with electricity and who/what could be affected a) Electric shock/electrocution and who affected i. The electrician undertaking the fault diagnosis ii. Other personnel working on or near the circuit being diagnosed iii. Customers/clients within the vicinity of the circuit being diagnosed iv. General public/children within the vicinity of the circuit being diagnosed b) Loss of supply to circuits and or safety services during fault diagnosis and who/what could be affected i. The building occupants in the event of fire due to the loss of supply to the fire alarm ii. Patients, where life-support/medical equipment supplies are affected causing risk to life iii. People in lifts, trapped in the event of supply loss iv. Air quality issues due to loss of supply to ventilation and extraction systems

	v. Overheating issues due to loss of supply to ventilation systems causing air quality issues or overheating
1.2 The Health and Safety requirements and safe working procedures relevant to diagnosing and correcting electrical faults.	1.2.1 Health and Safety requirements a) Working in accordance with safe systems of work i) Preparation and following of risk assessments ii) Preparation and following of method statements iii) Following permit to work systems b) Safe use of tools and equipment c) Safe and correct use of measuring instruments d) Provision and use of PPE e) Reporting of unsafe situations 1.2.2 Safe working procedures whilst carrying out fault diagnosis: a) Use of barriers to prevent unauthorised access to the work area b) Positioning of notices to advise why access is restricted in a particular area c) Safe isolation i) Obtain permission to start work (a Permit may be required in some situations) ii) Identify the source(s) of supply using an approved voltage indicator or test lamp iii) Prove that the approved voltage indicator or test lamp is functioning correctly iv) Isolate the supply(s) v) Secure the isolation with an appropriate device vi) Prove the system/equipment is DEAD using an approved voltage indicator or test lamp vii) Prove that the approved voltage indicator or test lamp is functioning correctly

	viii) Put up warning signs to tell other people that the electrical installation has been isolated ix) Once the system/equipment is proved DEAD, work can begin

Learning outcome 2

Understand the importance of reporting and communication in fault diagnosis

Topic	**Content** What needs to be covered:
2.1 Documentation relevant for reporting fault diagnosis	2.1.1 Documentation which may be referenced to aid fault diagnosis work, as relevant to the circumstance: a) Minor Electrical Installation Works Certificate(s) b) Electrical Installation Certificate(s) c) Electrical Installation condition Report d) Maintenance logs for the circuit and or faulty equipment e) Manufacturer's information and instructions for the equipment f) Circuit charts for the installation g) Circuit diagrams for the installation h) Reports sheets of any previous issues that have been identified and how and when these were resolved, if applicable.
2.2 The implications of a fault diagnosis for customers and clients	2.2.1 Potential risks where supplies are disconnected when carrying out fault diagnosis work: a) Loss of power to small power and lighting circuits b) Loss of power to essential systems including i) Lifts ii) Heating c) Loss of power to critical systems including i) Medical oxygen ii) Medical drips

	iii) Life support systems d) Loss of power to alarm systems i) Fire alarm ii) Nurse's call iii) Gas detection systems e) Loss of power to IT systems f) Loss of power to emergency lighting systems
2.3 The communication requirements with relevant personnel in fault diagnosis	2.3.1 Persons who may need to be communicated with during fault diagnosis work: a) Clients/Customers to advise as to the progress of the work b) Work colleagues to make aware of the work being undertaken c) Other workers/contractors working in the same location to be kept suitably informed of any work being carried out and precautions that must be taken d) Representatives of other services working in the premises to be kept suitably informed of any work being carried out and precautions that must be taken 2.3.2 Potential implications of poor communication dependant on circumstance: a) Could delay repairs and lead to increased loss of production/productivity b) Could prevent proper planning of any stoppage in production to facilitate diagnosis and rectification work c) Could increase the risks of injury to those working in and/or visiting the location d) Could increase the risk of critical supplies being disconnected, causing injury or danger e) Could prevent or delay gaining permission to access parts of the installation whilst carrying out diagnosis work

Learning outcome 3

Understand the nature and characteristics of electrical faults

Topic	Content What needs to be covered:
3.1 Electrical faults and potential causes.	3.1.1 Potential electrical faults: a) Loss of supply to an entire installation b) Loss of supply to a section or circuit within an installation c) Excessive or unexpected voltage drop within a circuit d) Polarity i) Incorrect supply polarity ii) Incorrect circuit polarity e) Component/equipment malfunction/failure f) Operation of overload or fault current protective devices g) Arcing parallel and series arcs or operation of AFDD h) High resistance connections i) Transient overvoltages j) Cable insulation failure and/or damage k) Open circuit l) Earth faults m) Short circuits 3.1.2 Some potential causes: a) Loss of supply to an entire installation – storms affecting the network supply system or overload of supply cut-out fuse b) Loss of supply to a section or circuit within an installation – broken connection within a circuit or a protective device having operated c) Excessive or unexpected voltage drop within a circuit – high resistance connection in circuit or excessive load on circuit d) Incorrect supply polarity – DNO incorrect wiring e) Incorrect circuit polarity – Incorrect wiring within premises or cross connections f) Component/equipment malfunction/failure – overvoltage or overheating g) Operation of overload or fault current protective devices – too much load on a circuit or a short circuit or earth fault on the circuit protected

	h) Arcing parallel and series arcs or operation of AFDD – short circuit between live conductors or a loose connection within a live terminal i) High resistance connections – loose termination screw or poor termination j) Transient overvoltages - lighting stroke/strike or switching of inductive or reactive loads k) Cable insulation failure and/or damage – physical damage to cable causing earth faults or short circuits l) Open circuit – broken conductor due to damage or incorrect terminations
3.2 The most likely locations of electrical faults in wiring systems, equipment and accessories	3.2.1 Locations where faults are most likely to be found: a) At terminations/connections i) Within distributions board ii) At equipment/accessory terminations b) Within equipment/accessories c) Within appliances d) Faulty instrumentation e) Within cables buried in the fabric of a wall f) Within conduit or trunking systems g) External to the premises in network power lines

Learning outcome 4

Understand fault diagnosis procedures

Topic	**Content** What needs to be covered:
4.1 The hazards and working practices to consider when carrying out fault diagnosis work.	4.1.1 Working practices which may be applicable to fault finding work: a) Lone working – working outside opening hours within a customer's premises b) Hazardous areas – areas where potentially dangerous chemicals and/or gasses are stored, transmitted and/or used

c) Confined spaces – loft, understairs, under floors, voids, service ducts
d) Fibre-optic cabling – used extensively in telecommunication applications
e) Electro-static discharge – created by friction between certain materials
f) Electronic devices – Used extensively in most installations and equipment
g) IT equipment – computer systems and embedded processors in various items of equipment, storage chips/drives within equipment
h) Presence of batteries – Lithium, lead acid, nickel cadmium and nickel-metal hydride used for supply back-up and energy storage systems
i) Additional source of energy – Small scale generation systems such as solar PV, micro wind, CHP, back-up or off-grid engine driven generators, capacitors, UPS systems
j) Time controlled devices – switching supplies to circuits for loads such as heating, lighting and for use of off-peak electricity such as for storage heaters

4.1.2 Hazards arising from working practices:

a) Lone working – increased risk from an injury or illness where unable to seek immediate help
b) Hazardous areas – hazardous and/or explosive chemicals/vapours/gasses may be present
c) Confined spaces – risk of gas or vapour build-up causing suffocation, could get physically stuck trying to more within location, increased difficulty in rescuing anybody injured
d) Fibre-optic cabling – injuries from glass shards, eye damage if end of cable stared into
e) Electro-static discharge – damage to electronic components from static discharge
f) Electronic devices – damage by overvoltage surges
g) IT equipment – potential damage and risk if IT equipment not down-powered in the correct way

	h) Presence of batteries – risk of chemical burns, risk of supplies still being live when otherwise isolated, risk of arcing from short circuits i) Additional source of energy – risk of circuits still being live when otherwise isolated i) Capacitive circuits ii) UPS circuits j) Time controlled devices – risk of delayed energisation of cables or equipment
4.2 The logical stages of fault diagnosis	4.2.1 Logical stages prior to and during fault diagnosis: a) Discussion with relevant persons to determine the nature and characteristics of the fault b) Identification of symptoms c) Collection and analysis of data d) Use of relevant documentation e) Use of own previous experience f) Checking and testing relevant items and at relevant points g) Interpreting results/information h) Notify client if additional cost will be involved and/or if danger present i) Fault rectification if practicable j) Undertake appropriate inspection and testing if rectified k) Functional testing if rectified l) Restoration if fault rectified m) Notify client when work complete
4.3 The appropriate test instrument/s for fault diagnosis work	4.3.1 Test instruments: a) Approved voltage indicator: checking for presence of voltage b) Low resistance ohm meter: measuring continuity values c) Insulation resistance tester: measuring Insulation resistance values d) EFLI and PFC tester: measuring values of earth fault loop impedance and prospective fault current e) RCD tester: checking RCD trip times

	f) Phase sequence tester: checking the phase sequence of three phase supplies g) Additional test instruments which may be required for fault diagnosis: i) Multimeter: taking measurements on electronic circuits ii) Clamp ammeter/tong tester: measuring current values (no need to access live parts)
4.4 How test instrument/s are confirmed to be fit for purpose and functioning correctly	4.4.1 Confirm test instrument is fit for purpose and safe to use: a) Free from damage b) Instrument calibration within date or tested on a checkbox (if applicable) c) Offsetting lead resistance for continuity tests by zeroing/nulling leads d) Check battery level is sufficient to perform the required test(s) e) Check functionality of instrument where possible f) Conforms to appropriate standards: i) GS38 test leads and probes (if applicable to the particular test) ii) BS EN 61557 - Electrical safety in low voltage distribution systems up to 1000 V AC and 1500 V DC equipment for testing & measuring.
4.5 The appropriate tests for fault diagnosis	4.5.1 Tests which could be required as part of fault diagnosis: a) Continuity: to check for open circuits b) Insulation resistance: to check for low insulation resistance values caused by damage c) Polarity: to confirm correct connections d) Earth fault loop impedance: to measure values of earth fault loop impedance to check compliance with BS 7671 e) RCD operation: to check correct operation of the device

	f) Current and voltage measurement: to check for possible overload and volt drop g) Phase sequence: to check for correct rotation of three phase equipment h) Functional testing/checking: to check that repaired equipment functions properly

Learning outcome 5

Understand the procedures for correcting electrical faults

Topic	Content What needs to be covered:
5.1 Factors which can affect the decision whether to repair or replace faulty equipment.	5.1.1 Factors which can affect the decision whether to repair or replace a piece of faulty equipment: a) The preference of the customer(s) b) Cost of the repair in relation to the cost to replace c) Availability new equipment or replacement parts d) Availability of suitably competent operatives e) The amount of downtime required for each option f) Legal and regulatory requirements g) Access to repair systems and equipment h) Requirement to provision of emergency or stand by supplies if applicable
5.2 The procedures for verifying that a fault/s has been rectified suitably for the situation	5.2.1 Procedures which could be required to verify rectification of faults: a) Inspection b) Continuity testing c) Insulation resistance testing d) Polarity testing e) Checking presence of supply f) Earth fault loop impedance testing g) Protective device operation h) Current measurement

	i) Voltage measurement j) Phase sequence testing k) Functional testing/checking

Learning outcome 6

Be able to perform fault diagnosis

Topic	Content What needs to be covered:
6.1 Apply appropriate methods when carrying out fault diagnosis work**.**	6.1.1 Methods of fault diagnosis: a) Determining nature/characteristics of the faults in discussion with customer b) Evaluate symptoms of faults c) Use of sources/types of information d) Carry out visual inspection e) Carry out relevant tests f) Evaluate test results g) Diagnose faults h) Recommend how to rectify faults i) Retest as applicable after fault rectification j) Restore work area to a functional and safe state
6.2 Follow safe working procedures when diagnosing electrical faults	6.2.1 Safe working procedures: a) Safe isolation b) Consideration of risk c) Safe use of test equipment
6.3 Diagnose electrical faults using appropriate test methods for fault symptoms	6.3.1 Electrical faults: a) Open circuit b) Short circuit c) Earth fault d) Reverse polarity / cross connection e) High conductor resistance f) Low insulation resistance

	6.3.2 Test methods: a) Visual inspection b) Continuity tests c) Insulation resistance tests
6.4 Evaluate test results during and following diagnostic work	6.4.1 Test results to be evaluated, as applicable: a) Continuity b) Insulation resistance c) Polarity d) Earth fault loop impedance e) RCD operation f) Current and voltage measurement g) Functional testing/checking 6.4.2 Publications which could need to be referenced. a) BS 7671 b) Guidance Note 3 c) On-site Guide
6.5 Recommend the appropriate actions to rectify electrical faults.	6.5.1 Appropriate actions to be taken after diagnostic work: a) Specify how the fault could be rectified b) Specify requirement to retest rectified fault c) Functionally testing

Guidance for delivery

- Tips for tutors on how the unit may be delivered in an engaging way including:
- 1.2.2 Learners need to consider safe working procedures relevant to statutory requirements: Health and Safety at Work Act and Electricity at Work Regulations and Safe working procedures relevant to non-statutory requirements: BS 7671 and GS38 standard for test equipment.
- For 6.1, a) customer in this context is the person carrying out the assessment.
- Learners must know how to work safely following guidance from EaWR etc.
- Opportunities for visits/engagement with local industry and employers would be beneficial for learners, such as manufactures of cable, protective devise, isolators and switches, solar panels and electric vehicle chargers.

NB – Content included in this section cannot be assessed.

Suggested learning resources

Relevant books, websites to support the delivery of the content.

Books

BS 7671 - IET Wiring Regulations (Latest edition)
Electrical Installations Book 2, Peter Tanner, second edition, City & Guilds, 2019

Websites

www.iet.org/BS7671 : The Institute of Engineering and Technology

Unit 304 Electrical Design Practices and Procedures

Unit Level:	3
Guided Learning Hours (GLH):	170
Unit Aim:	The aim of this unit is to enable the learner to develop the knowledge and skills required to design, prepare and install wiring systems and associated equipment in buildings, structures and the environment. Learners will gain an understanding of the electrical supply systems and consumer equipment and apply cable design procedures in accordance with approved industry practices, statutory and non-statutory regulations.
Assessment Method:	Multiple choice question paper Design assignment
Links to Apprenticeship Standard:	Installation and Maintenance Electrician ST0 152 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcome 1

Understand how to prepare for the installation of wiring systems

Topic	Content What needs to be covered:
1.1 The sources of statutory and non-statutory information which may be used when undertaking electrical design	1.1.1 Relevant sources of information: a) Statutory i) Electricity at Work Regulations ii) Health and Safety at Work, etc. Act iii) Building Regulations b) Non-statutory: i) IET Wiring Regulations (BS 7671) ii) IET On-site guide iii) IET Guidance Note 1 iv) Manufacturers' data
1.2 The requirements to ensure that electrical work sites are correctly prepared in accordance with Health and Safety legislation	1.2.1 The requirements and responsibilities to ensure electrical worksites are correctly prepared a) Requirements i. Safe access/egress ii. Risk assessments carried out iii. Method statements in place iv. Checking equipment v. Permit to work b) Responsibilities i. Employer • Provide appropriate PPE • Provide adequate appropriate training • Provide safe and appropriate plant and equipment • Use of visitor's book to monitor visitors to the site in case of an emergency • Provide adequate welfare facilities

	• Ensure a safe work environment ii. Employee • Act in a safe manner at all times avoiding actions that could risk harm to themselves or others • Use the PPE provided by employer correctly and without modification • Report any defects or missing PPE to their employer • Follow Risk Assessments and Method Statements as appropriate to the task.
1.3 The potential pre-existing damage and dangerous findings to customer/client property prior to commencement of work activity	Survey report (domestic, industrial) to identify: 1.3.1 Pre-existing conditions that may be present in old installations a) Any pre-existing damage that alters the scope of works 1.3.2 Dangerous situations or materials: a) Structural failing b) Asbestos c) Previous poor standard of work
1.4 The processes of checking and reporting any pre-existing damage to customer/client property	1.4.1 Processes to be followed to check for existing damage: a) Visual pre-work survey of the work area to identify any pre-existing damage b) Evidence collection and documentation, if applicable, including photographic evidence. c) Inspection and testing of existing circuits 1.4.2 Report if existing damage is discovered: a) Communication with the client to discuss any identified items b) Written notification to be used for future proof c) Get the client's acceptance in writing

	d) Any dangerous findings must be reported to the client e) Where pre-existing damage alters the scope of works, this must be agreed with the client before the work can commence
1.5 The suitability of different methods for protecting the fabric and structure of the property before and during electrical work	1.5.1 Suitable methods for protecting the property, fixtures and fittings: a) Floor protection i) Dust sheets ii) Correx iii) Plywood b) Wall protection: i) Plastic sheeting c) Access/egress route protection: i) Sheeting ii) Boarding iii) Taping iv) Stair runners d) Surface protection: i) Dust sheets ii) Cordex iii) Plywood iv) Plastic sheeting e) Health and safety implications i) trips ii) slips 1.5.2 Fabric and structure: a) Items that may need protection: i) ceramic finishes ii) granite iii) wood iv) metallic surfaces v) carpet

Learning outcome 2

Understand the applications of wiring systems

Topic	Content What needs to be covered:
2.1 The constructional features of electrical cables	2.1.1 Constructional features and limitations of various cable types: a) Temperature limitation of cable insulation b) Materials used for cable conductor insulation and cable sheaths: i) 70 °C thermoplastic (PVC) ii) 90 °C thermosetting (XLPE) iii) Synthetic-based rubber iv) Silicon v) Magnesium oxide (as used in MICC) – insulation only, sheath if applicable, PVC c) Additional considerations related to armoured cables: i) SY (control circuits) - braid to be used as a shield rather than cpc ii) Steel-wire armour – armour may be used as the circuit cpc d) Types of conductor i) Stranded ii) Solid core iii) Fine-stranded e) Materials used for live and protective conductors i) Copper ii) Aluminium iii) Steel 2.1.2 Types of electrical cable with reference to On-site Guide Appendix C: a) Single and multicore thermosetting insulated cables b) flexible cables c) Single and multicore thermoplastic (PVC) and thermosetting insulated cables and flexible cables d) PVC/PVC flat profile cable e) MICC (with and without PVC sheath)

	f) Steel-wire armoured (SWA) cables g) Armoured/braided flexible cables and cords (SY) h) Data cables including power over ethernet (PoE) i) Fibre optic data cable j) Fire resistant cable, such as FP200 k) Cables suitable for DC systems.
2.2 The characteristics of containment, support and wiring systems used in electrical installations	2.2.1 Containment types and cable support systems, materials and considerations: a) Types of containment i) Trunking ii) Conduit iii) Flexible conduit iv) Accessible service channels/ducts v) Underground ducting b) Materials used for containment i) PVC ii) Painted steel iii) Galvanized steel iv) Stainless steel c) Construction of containment systems i) Making bespoke parts ii) Buying pre-formed parts d) IP requirements for cable containment systems i) Minimum of IP4X or IPXXD ii) Any lid must be removable only with the use of a tool or deliberate action e) Cable support system i) Cable basket to support data cables ii) Cable ladder to support large SWA cables iii) Cable tray to support small/medium SWA cables f) Other installation methods i) Clipped/cleated directly to a surface ii) Embedded within masonry/plaster iii) Buried directly in the ground 2.2.2 Additional considerations relating to choice of cable retainment and fixings:

	a) Fixings must be suitable for the cable or containment they support b) Minimum fixing distance from the On-site Guide Appendix D i) Importance of fire rated fixings where cable could be subject to premature collapse before the building fabric, impeding evacuation and/or firefighting activities ii) Steel conduits iii) Steel trunking iv) Metal fixings 2.2.3 Wiring systems and circuit types: a) Final circuits: i) Radial circuit arrangements ii) Ring circuit arrangements iii) Lighting systems and circuits iv) Power systems v) Socket-outlet circuits vi) Electric vehicle charging circuits b) Distribution circuits: i) Mains ii) Sub-mains c) Environmental control/building management systems d) Emergency management systems e) Security and safety systems: i) Fire alarm/prevention ii) Unlawful entry iii) Emergency lighting f) Closed Circuit TV, communication and data transmission systems g) Broadband, wired networks and WI-FI h) Wired and wireless lighting or power control systems.
2.3 Determination of the size of conduit and trunking as appropriate to the size and number of cables	2.3.1 Size of conduit and trunking using the information taken from the On-site guide: Appendix E: a) Containment capacities

2.4 The factors which affect the selection of wiring systems, associated equipment and enclosures.	2.4.1 Factors which must be accounted for: a) External influences included in BS 7671 Appendix 5: i) Construction of building ii) Utilisation iii) Environment iv) Concise list of external influences b) Considerations to facilitate future additions to an electrical installation: i) Ease of adaptation in future ii) Capacity to allow for expansion iii) Accessibility of access points to facilitate future cable and equipment installation.
2.5 Suitable wiring systems and equipment appropriate to the installation	2.5.1 Key considerations when selecting wiring systems and containment: a) Impact protection suitable for the location and any risks of impact associated with the intended use of the location b) The material or materials used in the building construction c) Any expansion/contraction of the building structure and or containment system d) Environmental conditions such that they could degrade or damage the wiring system e) UV degrading for white PVC in sunlight

Learning outcome 3

Understand the practices and procedures for carrying out electrical work

Topic	**Content** What needs to be covered:
3.1 The procedures for selecting appropriate tools and materials for safe use	3.1.1 Procedures: a) Preparing and following a risk assessment b) Preparing and following a method statement

	c) Checking suitability of the tool for the specific task to include the correct voltage rating, if applicable d) Check the condition of all tools before each use e) Ensuring appropriate training in the use of tools has been received i) Use of power tools in line with risk assessment and manufacturer's instructions ii) Toolbox talks prior to tasks commencing 3.1.2 Safe use: a) Reading and following tool manufacturer's instructions b) The Control of Substances Hazardous to Health Regulations (COSHH) c) Personal protective equipment (PPE) as applicable to the task d) Provision and Use of Work Equipment Regulations (PUWER) e) Use of VDE tools where applicable
3.2 The equipment for measuring and marking out wiring systems, equipment and enclosures	3.2.1 Equipment which can be used when marking out prior to installing electrical systems: a) Laser level: Projects lines onto surfaces b) Scribe: used to mark metal surfaces c) Spirit level: Uses a bubble in device to show horizontal and vertical levels d) Plumb line: Uses gravity to indicate straight vertical lines e) Chalk line: Uses chalk to mark on to the surface to show straight lines f) Set Square: Used to mark 90^{o} angles onto surfaces g) Combination square: Used to mark various angles onto surfaces h) Tape measure: Used to take measurements.
3.3 The criteria for selecting tools and equipment for fixing and installing	3.3.1 Criteria for selecting: a) Building fabric

wiring systems, associated equipment and enclosures	b) Load bearing c) Manufacturer's guidance d) Appropriate training for specialised tools: nail gun
3.4 The suitability of fixing devices for different environments, building materials and applications	3.4.1 Choice of fixing devices in relation to suitability: a) Cost of the fixing type b) Load bearing capacity of the fixings c) Ease of use of the fixings d) External influences, to Appendix 5 of BS 7671, which may affect the suitability or longevity of the fixings 3.4.2 Fixing devices and their application: a) Countersunk screws used with counter-sunk holes b) Round-head screws used with flat surfaces c) Chemical fixing including glues and resins used in masonry walls d) Drywall fixings, including spring toggles and hollow wall anchors, used in plasterboard walls and ceilings e) Corrosion resistance fixings, including stainless steel and galvanised screws and bolts, used in damp environments f) Cleats used to support SWA cables g) Clips used for flexible and flat-profile cable h) Metal fixings used to prevent premature collapse in the event of a fire (see BS 7671 Regulation 521.1.202) i) Cable ties including plastic and metal used to secure cables to cable tray j) Wall bolts used to support heavy objects in masonry walls
3.5 The installation methods and considerations to ensure domestic, commercial, and industrial specifications are met in accordance with statutory and non-statutory regulations	3.5.1 Installation methods of cables: a) Cable tray b) Trunking c) Conduit d) Basket e) Ladder f) Steel-wired armoured cable (SWA)

	g) Clipped direct 3.5.2 Considerations: a) Longevity of the wiring system is appropriate for circumstance b) External influences as per BS 7671 Appendix 5 c) Aesthetics to be suitable for the client d) Accessibility for initial installation and future maintenance 3.5.3 Statutory and non-statutory regulations and guidance: a) Statutory i) Building Regulations: Part A: structure Part B: Fire safety Part E: resistance to sound Part F: Ventilation Part L: Conservation of fuel and power, Part M: Access to and use of buildings Part P: Electrical safety Part R: Infrastructure for electrical communications Part S: Infrastructure for charging electric vehicles ii) Electricity at Work Regulations (EaWR) b) Non-statutory i) BS 7671 ii) IET Guidance Note 1 iii) Approved Documents (to the Building Regulations as in 3.5.3 a)) iv) Manufacturer's instructions v) Approved Codes of Practice (ACOPs)
3.6 The methods and considerations for restoring the building fabric upon completion of work	3.6.1 Methods for restoring the fabric of a building: a) Replacing plasterboard sheets or sections b) Methods for filling holes and indentations in walls and ceilings

i) Using plaster to repair small sections of wall or ceiling
ii) Using wall and wood filler paste to repair small sections of wall or ceiling
iii) Using expanding foam to fill holes
iv) Techniques for repairing lath and plaster

c) Hard wall skimming over cable channels and/or damage
d) Protection against fire spread between compartments
i) Using fire battens
ii) Using fire pillows
iii) Using intumescent fire sealant
iv) Using fire rated expanding foam

3.6.2 Considerations to be made, as relevant, before undertaking electrical work in an existing premises (The way to restore must be considered before any damage is caused):

a) Fire rating of the walls and ceilings
i) Part B of the Building Regulations in relation to electrical work
b) Acoustic protection
i) Part E of the Building Regulations in relation to electrical work
c) Environmental considerations
i) Disposal of waste products
ii) Impact of products on the environment when manufactured and/or used
d) Control of Substances Hazardous to Health (COSHH)
e) Aesthetics
i) As per client taste/requirements
ii) Matching existing finish where required by the customer
f) Building fabric
g) Restoration techniques
i) Foam fillers
ii) Plastered walls, partitions and ceilings
iii) Solid masonry walls and partitions

	iv) Hollow and/or brittle masonry walls and partitions v) Stud walls vi) Plasterboard ceilings vii) Thermal insulation in walls and above ceilings viii) Fire compartments (where required) ix) Lath and plaster walls and ceilings x) Historic building restoration techniques

Learning outcome 4

Understand the characteristics and applications of electrical supply systems and consumers' equipment

Topic	Content What needs to be covered:
4.1 The characteristics and applications of earthing arrangements	4.1.1 Earthing arrangements: a) TT b) TN-S c) TN-C-S i) PME ii) PNB d) IT e) TN-C 4.1.2 Characteristics of earthing arrangements: a) Z_e b) PFC c) Neutral current diversion appearing on earthing and bonding systems d) Typically quoted maximum impedances of each supply earthing arrangement as per the On-site Guide Chapter 1 e) The importance of Automatic Disconnection of Supply (ADS) and fault current in relation to the design of electrical installations

	f) Limitations and additional risks of TT earthing systems g) Values of earth electrode resistance exceeding 200 Ω are classed as unstable h) Limitations and additional risks of earthing systems containing a PME PEN conductor. 4.1.3 Applications: a) Where an IT earthing arrangement may be required, such as medical and petrochemical premises b) Where a TN-C earthing arrangement may be found and why it isn't commonly used
4.2 The characteristics and compatibility of electrical supply systems	4.2.1 Characteristics of electrical supply systems: a) Standard conductor arrangement i) Single-phase: 2 wire ii) Two-phase: 3 wire iii) Three-phase: 3 wire iv) Three-phase and neutral: 4 wire c) AC systems d) DC systems e) Other local sources of supply including equipment electric vehicle to grid (V2G) i) Prosumers electrical installations and island mode systems (see BS 7671 Chapter 82) ii) Smart and dumb metering and the uses for each iii) Load control/shedding and the reasons to provide this facility 4.2.2 Compatibility: a) Electrical demand, three phase supply for larger loads b) Installation equipment suitable to earthing arrangement c) Suitability voltage and current ratings of the supply
4.3 The considerations for electrical installations and systems with regard to	4.3.1 Considerations which must be made, where applicable, when designing electrical installations:

provision for isolation, switching and protection of circuits	a) Safe isolation can be safely and securely carried out b) Emergency switching is provided where there could be danger, such as where machines with rotating parts are used. c) Functional switching is provided to facilitate use of the installation whilst minimising energy usage d) Maintenance isolation is provided where required e) Current carrying and voltage ratings of switching devices must be appropriate for their usage f) DC switching (quick make/break) is provided where required in DC circuits 4.3.2 Protection: a) Overcurrent protection (such as fuses, circuit-breakers or overload trips) b) Undervoltage protection (such as direct-on-line (DoL) or start-delta motor control starters) c) Earth fault protection (such as fuses, circuit-breakers, RCDs or RCBOs) d) Surge protection (SPDs) e) Arc fault protection (AFDDs) f) Short circuit (such as fuses or circuit-breakers)

Learning outcome 5

Understand earthing and protection

Topic	Content What needs to be covered:
5.1 The purpose of earthing conductors and bonding conductors	5.1.1 The purpose of: a) Automatic Disconnection of Supply (ADS) – see BS 7671 Regulation Group 411 b) Earthing exposed-conductive-parts to provide protection against electric shock c) Bonding of extraneous-conductive-parts to lower differential voltages in the event of an earth fault (provide equipotential)
5.2 The difference between extraneous and exposed conductive parts	5.2.1 Examples of items which could be extraneous-conductive-parts as defined in Part 2 of BS 7671 a) metallic water installation pipes b) metallic gas installation pipes c) other metallic installation pipework and ducting d) central heating and air conditioning systems e) Lightening protection systems 5.2.2 Examples of items which could be exposed-conductive-parts (unless part of Class II equipment): a) Metallic parts within an electrical installation b) Metallic parts of electrical equipment
5.3 The measures for protection against electric shock required by BS 7671	5.3.1 Measures used for protection against electric shock as given in Part 4 of BS 7671: a) The principle of electrical separation b) The principle of double and reinforced insulation c) The principle of SELV and PELV supplies d) The purpose and application of main protective bonding e) The purpose and application of supplementary bonding f) The requirement for and methods of providing additional protection

	g) Protective devices h) Automatic Disconnection of Supply (ADS)
5.4 The maximum disconnection times for different types earthing systems and circuits	5.4.1 Maximum disconnection times as stated in BS 7671 Regulations: a) 411.3.2.1 b) 411.3.2.3 c) 441.3.2.5
5.5 The component parts of earth fault loop impedance paths of each earthing arrangement	5.5.1 Component parts of different earthing systems: a) Line conductor b) Protective device c) PEN conductor d) Earth electrode e) Earthing conductor f) Circuit protective conductor (cpc) g) Separate metallic path h) General mass of earth 5.5 2 Earthing systems: a) TN-S b) TN-C-S c) TT d) IT
5.6 Applications of functional earthing	5.6.1 Equipment liable to emit protective conductor currents in normal operation: a) Computer systems (IT circuits) b) UPS and invertor drives c) Telecommunication systems 5.6.2 Risks associated with high protective conductor currents not due to a fault: a) Shock risk caused by the rise in potential of metalwork where disconnection from the protective conductor occurs. b) Shock risk when disconnecting protective conductors it circuit not safely isolated.

	c) Unwanted tripping of RCDs due to accumulation of protective conductor current being absent from the neutral conductor for the circuit.
5.7 The selection of suitably sized protective conductors in accordance with BS 7671	5.7.1 How to select and verify the cross-sectional area of suitably sized protective conductors: a) Comply with Chapter 54 BS 7671 requirements

Learning outcome 6

Understand protection against overcurrent

Topic	Content What needs to be covered:
6.1 Types of overcurrent and possible causes	6.1.1 Types of overcurrent fault: a) Short circuits between live conductors b) Earth faults between a live conductor and Earth c) Overloads where too high a load is applied to the circuit 6.1.2 Possible causes: a) Short circuit i) Loose wire in an appliance making contact with another terminal ii) A screw of nail though the cable connecting live conductors iii) Degraded cable insulation allowing live conductors to touch each other b) Earth fault i) Loose live wire in an appliance making contact with the Earth Terminal ii) Loose Earthed conductor in a distribution board making contact with a live terminal iii) Moisture within a junction box, luminaire or appliance iv) Failure of transformer, choke or motor winding insulation properties

	v) Degraded cable insulation allowing live conductors to touch earthed metal containment vi) A screw of nail though the cable connecting a live and an Earthed conductor c) Overload i) A fault within a piece of equipment increasing the current drawn ii) Incorrectly selected protective device rating for the circuit design current iii) Too many items of equipment connected to a socket-outlet circuit
6.2 The limitations of protective devices	6.2.1 Limitations of protective devices: a) Ability of device to detect specific faults (and not others): i) Short circuit ii) Earth fault iii) Earth leakage iv) Current capacity/rating v) Arc detection vi) Over-voltage protection vii) Breaking capacity viii) Overcurrent ix) Electronic monitoring 6.2.2 Protective devices: a) Fuses i) Semi-enclosed fuses to BS 3036 ii) Cartridge fuses to BS 1362 iii) HRC cartridge fuses to BS 88. b) Circuit-breakers i) To BS EN 60898 ii) BS EN 60947 Overcurrent part of RCBOs to BS EN 61009 c) RCDs i) To BS EN 61008 ii) RCBOs to BS EN 61009 d) AFDD devices i) Standalone

	ii) Combined with RCBO
6.3 The fault current capacities of devices	6.3.1 Fault current capacities of devices as given in Table 7.2.7(i) in the On site Guide: a) Breaking capacity for fuses b) Circuit-breakers i) I_{cn} ii) I_{cs}
6.4 The need for selectivity between protective devices	6.4.1 Need for selectivity in certain circumstances: a) Examples of where selectivity is required to avoid danger i) Loss of power to critical system such as life support ii) Loss of power to passenger lifts iii) Loss of power to pumps keeping cellars drained of water iv) Other essential systems such as fire detection systems v) Loss of supplies to lighting circuits where this could cause hazard and/or panic b) Examples of where selectivity is required to avoid inconvenience i) Where the operation of an upstream protective device shuts off an entire sub-distribution board instead of only the protective device for a single final circuit operating

Learning outcome 7

Understand electrical systems and circuits

Topic	Content What needs to be covered:
7.1 The types of standard electrical circuits	7.1.1 Electrical circuits: a) Standard circuits as given in the IET On-site Guide and Electrical Installation Design Guide i) Ring final circuits ii) Radial lighting circuits iii) Radial power final circuits
7.2 The applications of electrical systems and circuits	7.2.1 Types and applications for electrical systems and circuits: a) Distribution systems and sub-mains b) Environmental control and building energy management systems c) Emergency lighting systems i) Central battery systems ii) Self-contained d) Fire alarm and fire prevention systems e) Unlawful entry detection and burglar alarms f) UPS i) Dedicated to supply one piece of equipment ii) Central systems suppling several circuits and/or pieces of equipment g) Closed Circuit TV (CCTV) h) Communication and data transmission systems i) Broadband infrastructure ii) Wired networks within premises iii) WI-FI i) Machine control circuits j) Heating control circuits k) Battery storage systems and Electrical Energy Management Systems (EEMS) l) Photovoltaic arrays m) Wireless control systems such as heating control and lighting control n) Electric vehicle charging circuits and equipment:

	o) Electrical accessibility aids i) Stair lifts ii) Hoists/person lifters iii) Assisted living technologies iv) Person alert systems

Learning outcome 8

Be able to apply a cable design

Topic	Content What needs to be covered:
8.1 The purpose and methods of applying diversity factors when carrying out maximum demand calculations	8.1.1 Purpose of applying diversity when calculating maximum demand for installations: a) To reduce the minimum cross-sectional area required for distribution circuit cables b) To reduce the minimum cross-sectional area required for certain final circuits, such as those supplying cooking appliances c) To lower the minimum current rating of, and thus cost of installing, the incoming supply cables 8.1.2 Methods for applying diversity to maximum demand calculations: a) Approximations of demand using the designer's experience b) Applying diversity factors from Appendix A of the On-site Guide
8.2 Select suitable equipment, considering energy efficiency and sustainability, to relevant codes of practice and manufacturer's instructions	8.2.1 Sources of information and considerations with regard to energy efficiency and sustainability: a) Equipment manufacturer's data sheets b) Energy efficient design as per Appendix 17 of BS 7671 c) Recycling requirements at end of life d) Life cycle environmental cost

8.3 Calculate the maximum demand of an installation after the application of diversity	8.3.1 Calculate maximum demand using: a) Diversity values from the On-site Guide, Appendix A
8.4 Calculate design current	8.4.1 Design current: a) Single-phase loads b) Three-phase circuits loads c) Application of power factor to single and three-phase load calculations d) Legacy discharge lighting i) Multiply x 1.8 rule of thumb from appendix A of On-site Guide e) Light emitting diode (LED) lighting in reference to manufacturer's datasheets i) Surge current (if applicable) ii) Power factor (if applicable)
8.5 Select a suitably rated protective device type for a given circuit	8.5.1 Protective device ratings: a) Fuse rating b) Circuit-breaker rating c) RCBO rating 8.5.2 MCB/RCBO device type: a) Type B to be used where neither Type C nor Type D is required b) Type C to be used where the load has an inductive or capacitive inrush current c) Type D to be used where the load has inrush current too heavy for a Type C not to nuisance trip
8.6 Select the installation reference method	8.6.1 Installation reference method: a) Table 4A2 BS 7671 Appendix 4
8.7 Calculate appropriate cable rating factors	8.7.1 Cable rating factors: a) C_a (Ambient temperature) b) C_c (Buried cables) c) C_d (Depth of buried cables) d) C_f (Where a BS 3036 is the protective device)

	e) C_g (Grouping with other circuits) f) C_i (Cables within thermal insulation) g) C_s (Soil thermal resistivity in relation to buried cables)
8.8 Determine the minimum cross-sectional area of live conductors taking into consideration current carrying capacity and voltage drop	8.8.1 Current carrying capacity and voltage drop: a) Figures given in Appendix 4 of BS 7671 b) PVC temperature limitation (usually 70 °) d) Resistance of live conductors causing voltage drop (proportional the resistance per metre and the length of the conductors and the load being carried)
8.9 Identify if the voltage drop is acceptable	8.9.1 Voltage drop from a public low-voltage supply: a) Maximum voltage drop is the total from origin of the point of load see Paragraph 6.4 Appendix 4 of BS 7671 b) From Table 4Ab Appendix 4 of BS 7671 i) Maximum for circuits supplying lighting 3% of circuit nominal voltage ii) Maximum for circuits supplying other (than lighting) 5% of circuit nominal voltage
8.10 Verify if the disconnection times have been achieved	8.10.1 Verification that maximum disconnection times will be achieved: a) Verification from Max Z_s Tables 41.2-41.6 of BS 7671 as applicable to the maximum disconnection time and the type of overcurrent protective device.
8.11 Evaluate thermal constraints	8.11.1 Thermal constraints conforming with Regulation 543.1.3 of BS 7671: a) Calculation of prospective earth fault current b) Determination of actual disconnection time under earth fault conditions (see Appendix 3 of BS 7671) c) Tables 54.2 to 54.6 of BS 7671: i) Initial temperature ii) Final temperature

	iii) Referencing of k values for particular cable type, conductor material and cable arrangement d) Calculation using the adiabatic equation from 543.1.3 e) Evaluation of the resulting value of S (must be less than or equal to the cpc used to calculate the earth fault current)
8.12 Interpret the requirements of sources of technical information in the design of an installation	8.12.1 Sources of technical information which may be referenced as part of the design process: a) Client's specification (inc. Drawings) b) Manufacturer's data c) Statutory Regulations d) Approved Codes of Practice (ACOPs) e) BS 7671 f) IET On-site Guide g) Guidance Notes 1 to 8 from the IET h) ATEX Directive (for electrical installations in explosive atmospheres) i) Building Regulations and Approved Documents to these

Guidance for delivery

Tips for tutors on how the unit may be delivered in an engaging way including:

- Centres should constantly refer to the Regulations
  - The Electricity at Work Regulations (1989)
  - The current amendment of BS 7671
  - Health and Safety Act (1974)
  - Building Regulations (2000)

- For 8.12, in terms of content e) Atmosphere Explosive (ATEX) is a standard to be applied in explosive atmospheres and f) Explosive atmospheres are locations or structures that, due to their nature are prone to have explosive gases or ignitable material in the atmosphere to warrant the caution of deploying the ATEX standard.
- This unit could be delivered alongside Unit 6 Requirements for Electrical Installations to BS 7671

- Opportunities for visits/engagement with local industry and employers would be beneficial for learners, such as manufacturers of cable, protective devices, isolators and switches, solar panels and electric vehicle chargers

NB – Content included in this section cannot be assessed.

Suggested learning resources

Relevant books, websites to support the delivery of the content.

Books

BS 7671 - IET Wiring Regulations (Latest edition)
Electrical Installations Book 2, Peter Tanner, second edition, City & Guilds, 2019

Websites

www.iet.org/BS7671 : The Institute of Engineering and Technology

Unit 305 Organising and overseeing electrical work activities in buildings

Unit Level:	3
Guided Learning Hours (GLH):	60
Unit Aim:	The aim of this unit is to enable learners to gain an understanding of organising and overseeing work programmes within the construction sector. They will explore the requirements for tendering process and costing electrical work within the construction sector. Learners will gain an understanding of the practices and procedures for working with others when organising and overseeing work activities and explore the provision and storage of resources that are required for work.
Assessment Method:	Multiple choice question paper Design assignment
Links to Apprenticeship Standard:	Installation and Maintenance Electrician ST0 152 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcome 1

Understand the requirements for organising and overseeing work programmes

Topic	Content What needs to be covered:
1.1 The considerations of work allocations to electrical operatives	1.1.1 Considerations: a) Duties which may be undertaken by each different type of electrical operative b) Co-ordination with personnel from other trades whilst working on site.

1.2 The overriding principles for carrying out work activities	1.2.1 Overriding principles: a) Maintain the safety of the work environment b) Maintain cost effectiveness c) Ensure compliance with the programmes of work as scheduled
1.3 The industry standards that are relevant to activities carried out during the installation of electrical systems and equipment	1.3.1 Industry standards to be referenced as applicable: a) Management of Health and Safety Regulations b) Health and Safety at Work Act, etc c) Electricity at Work regulations d) Construction Design and Management e) BS 7671 Requirements for Electrical Installations f) BS EN graphical symbols
1.4 The procedures for dealing with changes to an original contract specification	1.4.1 Procedures to be followed where the original contract specification is amended: a) Variation order(s) b) Day work sheets c) Implications to the electrical work programme and that of other trades. 1.4.2 Consideration of the importance of procedures if changes are made to the original contract, and the potential resulting factors if these changes are not implemented: a) Not being paid for additional work undertaken. b) To be able to log all costs. c) Delays to the project completion, that could result in penalties.
1.5 The installations that require specialist advice or guidance	1.5.1 Installations where specialist advice is required: a) Hazardous installations i) Explosive gas atmospheres ii) Explosive vapour atmospheres iii) Combustible/explosive dust atmospheres iv) Mines and other underground workings v) Medical facilities such as operating theatres

	vi) Installations excluded from the scope of BS 7671
1.6 The influential factors and consequences that could affect the estimated completion time of electrical work	1.6.1 Influential factors that may affect the completion time of a contract: a) The deployment and availability of suitable personnel b) The delivery and availability of equipment, components, and material c) Adverse weather conditions d) Work to be completed by other services not being completed in time e) Specification variations after the contract has commenced f) Damaged tools and /or equipment required to undertake the contract g) Non-compliant materials leading to delays in receiving replacements h) Industrial action i) Theft of a tool(s) and/or material(s) j) National events (such as state funeral, act of terrorism) k) Wildlife and habitat conservation l) Archaeological discoveries 1.6.2 Consequences that may affect the completion time of a contract a) Penalty clause charges/deductions b) Liquidated damages c) Delays of the final completion and/or subsequent contracts d) Poor customer/client relations and poor reviews
1.7 Types of work programmes	1.7.1 Work programme analysis methods: a) Bar/Gantt charts b) Spreadsheets c) Critical Path Analysis
1.8 The procedure for completing and handing over work	1.8.1 Procedure to be followed: a) Inspection and testing

	b) Commissioning (may be part of inspection and testing) c) Handover i) Documentation: test certification, manufacturers' operating instructions for items installed, operation and maintenance manual for the installation ii) Demonstration of operation of electrical systems d) Project evaluation i) Client feedback surveys ii) Evaluation of areas for improvement for future contracts

Learning outcome 2

Understand the requirements for working with others when organising and overseeing work activities

Topic	Content What needs to be covered:
2.1 The purpose for effective communication when working with others	2.1.1 Effective communication: a) Methods i) Verbal communication ii) Written communication iii) Active listening iv) Email v) Messaging vi) Online meeting/file sharing platforms vii) Social media viii) Telecommunication/telephone ix) Use of appropriate industry terminology b) Advantages of using an effective communication technique i) Increased motivation to complete the tasks correctly ii) Instruction in how to complete tasks and standardisation between workers

	iii) Monitoring of the job progress and the strengths and weaknesses of operatives iv) Promoting co-operation and teamwork between work colleagues and other trades v) Informing people in advance of work being carried out c) Disadvantages (poor communication) i) Low team moral ii) Conflict between personnel iii) Difficult work conditions/environment iv) Loss of productivity 2.1.2 Other persons and organisations with which communication could be necessary: a) Customers b) Clients c) Site Managers d) Major and sub-contractors (where appropriate) e) Other tradespersons f) Occupiers of the premises g) Local Authorities/ Building controls h) Suppliers i) General public j) Your employer and/or line manager k) Utility companies
2.2 The methods of determining the competence of electrical operatives and ensuring continued professional development	2.2.1 Methods which can be used to assist validation of an electrical operative's competence: a) Checking competency cards i) CSCS/ECS cards ii) JIB cards iii) Continued professional development (CPD) record iv) Professional registration EngTech (or higher) v) Professional registration TMIET (or higher) b) Checking qualifications relating to i) Inspection and testing (initial verification and/or periodic inspection and testing)

	ii) Design and verification iii) BS 7671 Wiring Regulations iv) NVQ L3 Electrotechnical qualification v) Electrical vehicle charging installations vi) Solar photovoltaic (PV) installations c) Written references from previous employers and/or Tutors d) Informal/formal monitoring of performance on-site e) Competent Person Scheme Registration
2.3 The procedures for rescheduling work to co-ordinate with changing conditions in the workplace	2.3.1 Procedures to follow when rescheduling work programs: a) Site meetings b) Communication with clients and other relevant people c) Variation orders d) Revised programme of work(s) e) Revised critical path network(s)
2.4 The documentation required for work operations	2.4.1 Documentation required as applicable: a) Building Regulation approval(s) b) Variation order c) Purchase order d) Daywork sheets e) Timesheets f) Site diary g) Material requisitions h) Material delivery notes i) Operation and maintenance manual j) Compliance certificates k) As fitted drawings
2.5 The relevant, current employment legislation that affects roles and responsibilities	2.5.1 Relevant UK employment legislation: a) Employment Rights Act b) Data Protection Act c) Equality Act d) Human Rights Act 2.5.2 Roles and responsibilities, in line with relevant UK employment legislation, of:

	a) Employers b) Employees c) Sub-contractors

Learning outcome 3

Understand the requirements for organising the provision and storage of resources that are required for work activities

Topic	Content What needs to be covered:
3.1 The resource requirements relevant to the project	3.1.1 Resource requirements as relevant: a) Materials b) Components c) Plant d) Vehicles e) Equipment f) Labour g) Tools h) Measuring and test instruments.
3.2 The material checks required to suit the work programmes	3.2.1 Material checks: a) Take-off sheets from specification b) Compliance with the requirements of BS 7671 c) Compliance with product standards (as applicable) i) BS standards ii) BS EN standards iii) IEC standards iv) CE mark v) BSI Kite mark d) Bill of quantities i) The right type ii) Fit for purpose iii) In the correct quantity e) Suitable for work to be completed cost efficiently

3.3 The considerations and methods for the safe and effective storage of materials, tools and equipment	3.3.1 Considerations to be made in relation to tool and material storage: a) Possible theft b) Possible damage c) Site restraints in regards to location of storage d) Ease of delivery to the work area e) Distance of storage from site f) Accessibility of storage including limited time of access g) Delivery timings ensuring loads can be unloaded (where lifting equipment is required) 3.3.2 Potential locations for the storage of tools and materials: a) Storage containers b) Site box c) Locked rooms d) Company vehicle

Guidance for delivery

Tips for tutors on how the unit may be delivered in an engaging way including:

- Centres should constantly refer to the Regulations
- This unit could be delivered alongside Unit 4 Principles of Electrical Design
- For Topic 1.1, with reference to the range this requires learners to perform to their highest standard and to work within the conduct expected of an employee in the industry. Such standards are of high importance when co-operating with employer and/or customer during work activities.
- Opportunities for visits/engagement with local industry and employers would be beneficial for learners, such as manufacturers of cable, protective devices, isolators and switches, solar panels and electric vehicle chargers

NB – Content included in this section cannot be assessed.

Suggested learning resources

Relevant books, websites to support the delivery of the content.

Books

BS 7671 - IET Wiring Regulations (Latest edition)

Electrical Installations Book 2, Peter Tanner, second edition, City & Guilds, 2019

Websites www.iet.org/BS7671 : The Institute of Engineering and Technology

Unit 306 Understand the Requirements of Electrical Installations BS 7671:2018 (2022)

Unit Level:	Level 3
Guided Learning Hours (GLH):	70
Unit Aim:	This unit gives the learner an understanding of the content of BS 7671 and how this applies to electrical installations within its scope.
Assessment Method:	Multiple choice question paper
Links to Apprenticeship Standard:	Installation and Maintenance Electrician ST0 152 See also qualification content mapping to Occupational Standard (Appendix 1)

Learning outcome 1

Understand the scope, object, and fundamental principles of BS 7671

Topic	**Content** What needs to be covered:
1.1 Identify the scope of BS7671	1.1.1 Scope: a) Chapter 11 Scope
1.2 Identify the object of BS7671	1.2.1 Object: a) Chapter 12 Objects and effects
1.3 Identify the fundamental principles of BS7671	1.3.1 Fundamental principles a) Chapter 13 Fundamental principles

Learning outcome 2

Understand the definitions used within BS 7671

Topic	Content What needs to be covered:
2.1 Interpret the definitions used within BS7671	2.1.1 Definitions: a) Definitions b) Symbols c) Abbreviations
2.2 Relate the definitions to the regulations and appendices of BS7671	N/A

Learning outcome 3

Understand how to assess the general characteristics of electrical installations

Topic	Content What needs to be covered:
3.1 Interpret the requirements of assessing the general characteristics of electrical installations within the scope of BS767	3.1.1 General characteristics: a) Chapter 31 Purposes, supplies and structure b) Chapter 32 Classification of external influences c) Chapter 33 Compatibility d) Chapter 34 Maintainability e) Chapter 35 Safety services f) Chapter 36 Continuity of service

Learning outcome 4

Understand requirements of protection for safety for electrical installations

Topic	Content What needs to be covered:
4.1 Identify the requirements of protection for safety within the scope of BS 7671	4.1.1 Protection for safety: a) Chapter 41 Protection against electric shock b) Chapter 42 Protection against thermal effects c) Chapter 43 Protection against overcurrent

	d) Chapter 44 Protection against voltage disturbances and electromagnetic disturbances e) Chapter 46 Isolation and switching
4.2 Interpret how this applies to electrical installations within the scope of BS 7671	4.2.1 Protection a) Protection against electric shock b) Protection against thermal effects c) Protection against overcurrent d) Protection against voltage disturbances and electromagnetic disturbances e) Isolation and switching

Learning outcome 5

Understand the requirements for selection and erection of equipment for electrical installations

Topic	**Content** What needs to be covered:
5.1 Identify the requirements for selecting and erecting equipment and interpret how this applies to wiring systems	5.1.1 Selection and erection of equipment: a) Chapter 51 Common rules b) Chapter 52 Selection and erection of wiring systems c) Chapter 53 Protection, isolation, switching, control, and monitoring d) Chapter 54 Earthing arrangements and protective conductors e) Chapter 55 Other equipment f) Chapter 56 Safety services
5.2 Interpret how this applies to electrical installations within the scope of BS 7671	5.2.1 Selection and erection of equipment a) Common rules b) Wiring systems c) Protection, isolation, switching, control and monitoring d) Earthing arrangements and protective conductors e) Other equipment

	f) Safety services

Learning outcome 6

Understand the requirements of inspection and testing of electrical installations

Topic	Content What needs to be covered:
6.1 Identify the requirements for inspection and testing	6.1.1 Inspection and testing: a) Chapter 64 Initial verification b) Chapter 65 Periodic inspection and testing
6.2 Interpret how this applies to electrical installations	6.2.1 Inspection and testing: a) Chapter 64 Initial verification b) Chapter 65 Periodic inspection and testing

Learning outcome 7

Understand the requirements of special installations or locations as identified in BS 7671

Topic	Content What needs to be covered:
7.1 Identify the requirements for special installations	7.1.1 Special installations or locations: a) Section 700 General b) Section 701 Locations containing a bath or shower c) Section 702 Swimming pools and other basins d) Section 703 Rooms and cabins containing sauna heaters e) Section 704 Construction and demolition site installations f) Section 705 Agricultural and horticultural premises g) Section 706 Conducting locations with restricted movement h) Section 708 Electrical installations in caravan / camping parks and similar locations i) Section 709 Marinas and similar locations j) Section 710 Medical locations

	k) Section 711 Exhibitions, shows and stands l) Section 712 Solar photovoltaic (PV) power supply systems m) Section 714 Outdoor lighting installations n) Section 715 Extra-low voltage lighting installations o) Section 717 Mobile or transportable units p) Section 721 Electrical installations in caravans and motor caravans q) Section 722 Electric vehicle charging installations r) Section 729 Operating and maintenance gangways s) Section 730 Onshore units of electrical connections for inland navigation vessels t) Section 740 Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses u) Section 753 Heating cables and embedded heating systems
7.2 Interpret how these affect the general requirements of the regulations	N/A

Learning outcome 8

Understand the information contained within Part 8 and the appendices of BS 7671

Topic	Content What needs to be covered:
8.1 Identify the information contained in Part 8 of BS7671	8.1.1 Functional requirements: a) Chapter 82 Prosumer's low voltage electrical installations
8.2 Identify the information in the appendices of BS 7671	N/A
8.3 Specify how the information contained in the appendices is used to support electrical installation activities.	8.3.1 Appendices: a) 1. British standards to which reference is made in BS 7671 b) 2. Statutory regulations and associated memoranda c) 3. Time/current characteristics of overcurrent protective devices d) 4. Current-carrying capacity and voltage drop for cables e) 5. Classification of external influences f) 6. Model forms for certification and reporting g) 7. No7. Deleted by BS7671:2018+A2:2022 h) 8. Current-carrying capacity and voltage drop for busbar trunking and powertrack systems i) 9. Definitions – multiple source, DC, and other systems j) 10. Protection of conductors in parallel against overcurrent k) 11. Warning and user instruction labels l) 12. No12. NOT USED m) 13. Escape routes and fire protection n) 14. Determination of prospective fault current o) 15. Ring and radial final circuit arrangements, regulation 433.1 p) 16. Devices for protection against overvoltage q) 17. Energy efficiency

Guidance for delivery

Tips for tutors on how the unit may be delivered in an engaging way including:

- Centres should constantly refer to the regulations
- This unit could be delivered alongside Unit 2 inspection and testing and Unit 4 Principles of Electrical Design
- Opportunities for visits/engagement with local industry and employers would be beneficial for learners, such as manufacturers of cable, protective devices, isolators and switches, solar panels and electric vehicle chargers

NB – Content included in this section cannot be assessed.

Suggested learning resources

BS 7671 - IET Wiring Regulations (Latest edition)

Websites

www.iet.org/BS7671: The Institute of Engineering and Technology

Appendix 1 Qualification content mapping to Occupational Standard (ST0152)

The table below contain the mapping of the occupational standard ST0152 Knowledge, Skills and Behaviours (KSBs) to the City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma) (2366-03).

The KSB reference to each unit in this document is not exhaustive.

Unit	Knowledge, Skills, and Behaviours (KSBs) reference
301 Scientific principles	K9, K10, K11, K12 S9
302 Inspection, testing and commissioning of electrotechnical systems and equipment	K1, K2, K3, K7, K8, K9, K13, K15, K16 S1, S2, S3, S5, S7, S10, S12, S16, S17 B1, B3
303 Fault finding and diagnosis	K1, K2, K4, K5, K12, K13, K14 S1, S13 B4
304 Electrical Design Practices and Procedures	K3, K4, K7, K8, K10, K11, K12, K19 S2, S9, S11
305 Organising and overseeing electrical work activities in buildings	K2, K4, K6, K16, K17, K18, K19
306 Understand the Requirements of Electrical Installations BS 7671:2018 (2022)	K6, K7, K11, K18

Appendix 2 Glossary

The table below contain a glossary for the City & Guilds Level 3 Technical Occupational Entry in Electrical Installation (Diploma) (2366-03).

Acronym	Full term
AC	Alternating current
AFDD	Arc fault protection device
ACOPs	Approved Codes of Practice
CHP	Combined Heat and Power
COSHH	Control of Substances Hazardous to Health
C_a	Ambient temperature
C_c	Buried cables
C_d	Depth of buried cables
C_f	Where a BS 3036 is the protective device
C_g	Grouping with other circuits
C_i	Cables within thermal insulation
C_s	Soil thermal resistivity in relation to buried cables
cpc	Circuit protective conductor
DC	Direct current
DNO	Distribution network operators
DoL	Direct-on-line
EESS	Electrical energy storage systems
EEMS	Electrical Energy Management Systems
EIC	Electrical installation certificate
EMF	Electromagnetic Field
ELV	Extra low voltage
kA	Kiloamps
kVA	Kilovolt-amps
kV	Kilovolt

Acronym	Full term
kW	Kilowatt
LED	Light emitting diode
I_{PSCC}	Prospective short circuit current
I_{PEFC}	Prospective Earth fault current
I_{Pf}	Prospective fault current
I_{cn}	Rated short circuit capacity (marked on the device)
I_{cs}	The service short circuit capacity
LV	Low voltage
IP4X	Penetration by a solid foreign object ≥ 1 mm in diameter shall not be possible
IPXXD	Access by 100 mm length of wire from the csa 1.0 mm^2 shall not be possible
MICC	Mineral-insulated copper-clad
PEN	Protective earthed neutral
PME	Protective multiple earthing
PNB	Protective neutral bonding
PPE	Personal protective equipment
PVC	Polyvinyl chloride
RCBO	Residual current operated circuit-breaker with integral overcurrent protection'
RCD	Residual current device
R_1	Resistance of the line conductor
R_2	Resistance of the circuit protective conductor
SPD	Surge protection device
SWA	Steel-wire armoured
TN-C	Neutral and protective ground conductors
TN-C-S	Terre neutral combined separate
TN-S	Terre neutral separate
TT	Terre Terre
UPS	Uninterrupted power supply
V2G	Vehicle to grid
XLPE	Cross-linked polyethylene

Acronym	Full term
Z_e	Earth fault loop impedance
Z_s	Impedance
$Z_s$db	$Z_e+(R_1+R_{2submain})$ =Z_s@db

Appendix 3 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centre document library** on **www.cityandguilds.com** or click on the links below:

Centre Handbook: Quality Assurance Standards
This document is for all approved centres and provides guidance to support their delivery of our qualifications. It includes information on:

- centre quality assurance criteria and monitoring activities
- administration and assessment systems
- centre-facing support teams at City & Guilds/ILM
- centre quality assurance roles and responsibilities.

The Centre Handbook should be used to ensure compliance with the terms and conditions of the centre contract.

Centre Assessment: Quality Assurance Standards

This document sets out the minimum common quality assurance requirements for our regulated and non-regulated qualifications that feature centre-assessed components. Specific guidance will also be included in relevant qualification handbooks and/or assessment documentation.

It incorporates our expectations for centre internal quality assurance and the external quality assurance methods we use to ensure that assessment standards are met and upheld. It also details the range of sanctions that may be put in place when centres do not comply with our requirements or actions that will be taken to align centre marking/assessment to required standards. Additionally, it provides detailed guidance on the secure and valid administration of centre assessments.

Access arrangements: When and how applications need to be made to City & Guilds provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **Centre document library** also contains useful information on such things as:

- conducting examinations
- registering learners
- appeals and malpractice.

Useful contacts

Please visit the Contact us section of the City & Guilds website, **Contact us.**

City & Guilds

For over 140 years, we have worked with people, organisations and economies to help them identify and develop the skills they need to thrive. We understand the life-changing link between skills development, social mobility, prosperity and success. Everything we do is focused on developing and delivering high-quality training, qualifications, assessments and credentials that lead to jobs and meet the changing needs of industry.

We partner with our customers to deliver work-based learning programmes that build competency to support better prospects for people, organisations and wider society.
We create flexible learning pathways that support lifelong employability because we believe that people deserve the opportunity to (re)train and (re)learn again and again – gaining new skills at every stage of life, regardless of where they start.

The City & Guilds community of brands includes Gen2, ILM, Intertrain, Trade Skills 4U, Kineo and The Oxford Group.

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