Level 3 Certificate in Electrotechnical Technology

Scheme handbook

2330
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Level 3 Certificate in Electrotechnical Technology

This award is aimed at candidates who

- are following Modern Apprenticeship programmes
- who do and do not have access to an N/SVQ
- wish for career progression within the electrotechnical industry

This award is designed to contribute towards the knowledge and understanding for Electrotechnical NVQs at Levels 2 & 3 (City & Guilds 2356), containing skills and knowledge which reflect the scope of the National Occupational Standards.

Candidates must follow **one** of six occupational pathways. Successful candidates will receive a certificate endorsed with their chosen pathway:

Level 3 Certificate in electrotechnical technology - installation (buildings & structures)

Level 3 Certificate in electrotechnical technology - electrical maintenance

Level 3 Certificate in electrotechnical technology - instrumentation & associated equipment

Level 3 Certificate in electrotechnical technology - highway electrical systems & associated equipment

Level 3 Certificate in electrotechnical technology - electrotechnical panel building

Level 3 Certificate in electrotechnical technology - electrical machines rewind & repair

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General information

This certificate has been designed by City & Guilds to support government initiatives towards the National Qualifications Framework. It can contribute towards the knowledge and understanding required for the related N/SVQ while not requiring or proving evidence of occupational competence.

General structure

The Award is made up of units expressed in a standard format. Each unit is preceded by details of

- the structure of the unit
- the aims and general coverage of the unit
- the outcomes
- the assessment methods

Assessment and quality assurance

National standards and rigorous quality assurance are maintained by the use of

- City & Guilds set and marked written tests
- City & Guilds Assignments, marked by the centre according to externally set marking criteria, with quality assurance monitored by City & Guilds' external verification system.

The written tests assess knowledge and understanding.

Verification of Assignments

Although the Award does not imply occupational competence, it has a very close relationship with N/SVQ programmes. It is for this reason that, when assignments are assessed, it is important that reference is made to N/SVQ assessment methodology. Award assessors/tutors will need to be familiar with the occupational standards for Electrotechnical N/SVQs, because a similar system of internal verification is used. This means that the work of assessors involved in the qualification must be monitored by an Internal Verifier/scheme co-ordinator, to ensure that they are applying the standards consistently throughout assessment activities.

Assessors must ensure that candidates understand why a particular grade has been given for the award.

If a candidate's work is selected for verification, samples of work must be available to the appointed external verifier.

An external verifier will make an annual visit to the centre and their role includes the following:

- ensuring that internal verifiers are undertaking their duties satisfactorily
- monitoring internal quality assurance systems and sampling assessment activities, methods and records
- acting as a source of advice and support
- promoting best practice
- providing prompt, accurate and constructive feedback to all relevant parties on the operation of centres' assessment systems.

As assignments are designed to sample practical activities, it is essential that the centres ensure that candidates cover the content of the whole unit.

Assessment components are graded (Pass, Credit, Distinction). A pass is the achievement level required for the knowledge and understanding in an N/SVQ and generally represents the ability to follow instructions and procedures. Credit and distinction represent increasing levels of ability to adapt to changing circumstances and to independently resolve problems.

For candidates with particular requirements, centres should refer to City & Guilds policy document *Access to assessment, candidates with particular requirements*.

External verifiers act on behalf of City & Guilds to ensure that national standards are maintained. Full details of their role can be found in *Providing City & Guilds' Qualifications - a guide to centre and scheme approval*.

Centre and scheme approval

Centres wishing to offer City & Guilds qualifications must gain approval.

New centres must apply for centre and scheme approval.

Existing City & Guilds centres, will need to get specific scheme approval to run this Award.

Full details of the process for both centre and scheme approval are given in *Providing City & Guilds qualifications - a guide to centre and scheme approval* which is available from City & Guilds' regional offices.

City & Guilds reserves the right to suspend an approved centre, or withdraw its approval from an approved centre to conduct a particular City & Guilds scheme or particular City & Guilds schemes, for reasons of debt, malpractice or for any reason that maybe detrimental to the maintenance of authentic, reliable and valid qualifications or that may prejudice the name of City & Guilds.

GOLA registration

Centres are required to register as a GOLA centre before any tests can be scheduled. The form for this is available from the website www.cityandguilds.com/e-assessment

A centre only needs to register once for GOLA

There is a GOLA helpline number - centre enquiries and technical enquiries about GOLA can be directed to this number **0845 241 0070**.
Centres can also e-mail: gola@cityandguilds.com.

The following leaflets are available:

A centre's guide to global on-line assessment
A centre's guide to technical requirements for global on-line assessment
A centre's guide to administering global on-line assessment
A learner's guide to global on-line assessment.

Centres looking for general information about GOLA or copies of the GOLA leaflets are advised to use the website www.cityandguilds.com/e-assessment.

Course Design and entry requirements

Teacher/assessors should familiarise themselves with the structure and content of the award before designing an appropriate course; in particular they are advised to consider the knowledge and understanding requirements of the relevant N/SVQ. The award programme contains a core unit and two occupational units. It is strongly recommended that centres integrate the content of the core and occupational units as appropriate. As long as the requirements for the award are met, teachers/assessors may design courses of study in any way that they feel best meets the needs and capabilities of the candidates.

It is recommended that centres cover the following in the delivery of the course, where appropriate

- Key Skills (such as Communication, Application of Number, Information technology, Working with others, Improving own learning and performance, Problem solving)
- Health and safety considerations, in particular the need to impress to candidates that they must preserve the health and safety of others as well as themselves
- Equal opportunities
- Spiritual, moral, social and cultural issues
- Environmental education
- European dimension.
- Employment rights and responsibilities

It is **recommended** that centres and candidates complete an initial assessment plan to take into account

- Any prior learning that can be taken into account
- The type of course appropriate for the candidate
- The candidate's preferred learning styles
- Key skills strengths and weaknesses
- Any open or distance learning materials that will be used
- A target for completion of the award
- Links to employer's training programme.

It is **recommended** that **250** hours should be allocated for the core and occupational units required for certification. Approximately half of this time may be devoted to practical delivery.

City & Guilds does not itself provide courses of instruction or specify entry requirements. Within the context of this award centres should evaluate the abilities of the candidate to meet the technical requirements of the syllabus content and the assessments. Furthermore centres should ensure that candidates do not register for this award if they hold or are registered with City & Guilds or another awarding body for an award the same level and content.

Guidance notes on assessment

Section 1- Introduction

The City & Guilds Level 3 Electrotechnology qualification is designed to provide opportunities for candidates to gain accreditation for their individual level of understanding of the underpinning knowledge relevant to the appropriate related NVQ.

The emphasis is on 'learning by doing', not on competence. For this reason candidates are required to complete a number of assignments to show their attainment of practical skills which in turn implies understanding of the theoretical knowledge required to complete a number of activities successfully.

For the certificate at level 3 candidates will be required to achieve

- the **One** core unit (Unit 001)
- and **Two** units from the same occupational area (from Units 002 to 013)

Section 2 – Assessment

In order to gain the full certificate candidates **must** complete

one multiple-choice on-line test for the **core** unit.

two centre devised assignments, one for each of the nominated occupational units based on an assignment template provided for the occupational units and to include an underpinning knowledge test.

2.1 What is provided by City & Guilds

City & Guilds will provide on-line, on-demand testing using multiple choice questions, for the core unit.

City & Guilds will also provide

- an assignment template for each occupational unit
- a sample assignment for each occupational unit
- a selection of short answer question tests for each occupational unit.

Sample assignments and short answer question tests can be requested from the Building Services team on 020 7294 2731/2674. They will be provided electronically.

2.2 Assessment of Core unit

This unit will be assessed by an externally set multiple choice on-line test.
These tests are available on line through the City & Guilds GOLA system.

Each test will comprise multiple choice items in accordance with the test specification provided in this handbook.

2.2.1 On Line assessment requirements

Full details of the City & Guilds GOLA system requirements, becoming a GOLA centre and downloadable information sheets can be found at: http://www.cityandguilds.com/e-assessment

2.2.2 Further information

Any queries on the technical requirements for running City & Guilds' GOLA assessment should be directed to the GOLA helpline: **0845 2410 070**

2.3 Assessment of optional units

Each optional unit should be assessed by the use of an assignment.

The assignment should be produced by the centre in accordance with the template provided by City & Guilds. Alternatively centres may use the sample assignment(s) provided. It will be made up of a number of practical tasks and an underpinning knowledge test (City & Guilds set). The resultant level of candidate achievement will be graded. C*andidates MUST pass all tasks within an assignment.*

Assignments will provide opportunities for candidates to be assessed for a **sample** range of the practical activities required for the unit. Assignments will usually consist of several tasks. The range of assignments developed by the centre for each unit should ensure that all the practical activities for all the outcomes are assessed as the centre uses a range of assignments over a period of time.

City & Guilds will provide assignment templates from which centres should produce the assignments for the units contained in this award. Centres are required to use the templates provided by City & Guilds. Alternatively centres may use the sample assignment(s) provided. External Verifiers **must** approve all centre devised assignments prior to use by the centre. (see **2.5.5** page 15)

2.4.1 Assignment templates

Detailed assignment templates for **each** optional unit are provided as a separate document on request from the Building Services team on 020 7294 2716.

2.4.2 Guidance for Marking

Grading of assignments is Pass, Credit and Distinction; grades of Credit and Distinction are intended to distinguish those candidates who show greater degrees of autonomy in the way they organize themselves, or apply reflective thinking and originality in the completion of tasks.

Detailed marking and grading criteria are provided for each assignment in the Marking Criteria section of the assignment. The candidate must display satisfactory performance throughout the tasks. Failure to do so will result in the candidates requiring further training.

2.4.3 Marking assignments

Centres will be taking into account the following aspects of candidate's performance:

- planning, preparation and recording
- practical activity
- underpinning knowledge

Each aspect must be marked and awarded a Pass, Credit or Distinction. Specific guidance for marking is provided in the assignment's template. Candidates **must** achieve a **minimum** of a **pass** in **each** aspect of performance.

The marks that should be awarded for **planning, preparation and recording and underpinning knowledge** are as follows

Marks	
Pass	**1**
Credit	**2**
Distinction	**3**

(Note: half marks are not available)

The marks that should be awarded for the **practical activities** are as follows

Marks	
Pass	**2**
Credit	**4**
Distinction	**6**

(Note: these marks are not divisible ie, Pass candidates must be awarded 2 marks, Credit candidates 4 marks and so on)

The marks that should be awarded for the **underpinning knowledge tests** are as follows

Marks	
Pass	**1**
Credit	**2**
Distinction	**3**

(Note: half marks are not available)

To award an overall grade the number of marks given for each task is totalled and then a grade is applied as follows

Marks	Grade
4-6	**Pass**
7-9	**Credit**
10-12	**Distinction**

2.4.4 Recording marks and grades

To record candidate marks and overall grades for each completed assignment, assessors should enter details onto the appropriate Assignment marksheet.

For example, below is a completed Assignment marksheet as it would appear in the candidates' Assignment Guide. It shows how the overall grade was produced.

	Pass	Credit	Distinction
Planning, preparation and recording	1		
Practical activity		4	
Underpinning knowledge			3
		Total	8
		Grade	**CREDIT**

2.4.6 Feedback

The assignments are intended as a formal assessment of candidates' practical skills. They are not designed as teaching aids and candidates should not be entered until they are ready. Should a candidate fail any of these tasks other than on health & safety grounds, as stated above, appropriate feedback should be given by the assessor both to the candidate and the tutor concerned.

Assessors must ensure that candidates understand why a particular grade has been given for the award.

If a candidate's work is selected for verification, samples of work must be available to the appointed external verifier.

2.5 What centres need to do

2.5.1 Machinery, tools and equipment

Centres must have access to sufficient equipment in the college, training centre or workplace to ensure candidates have the opportunity to cover all of the practical activities.

It is acceptable for centres to use specially designated areas within a centre for some of the units: eg to train and assess the installation of specialised electrical systems, alignment and setting up of electric motors and driven devices (pumps, compressors generators etc.)

The equipment, systems or machinery must be of an industrial standard and be capable of being used under normal working conditions: eg electric motors must have a method of applying sufficient power and not merely be connected up to show movement.

2.5.2 Producing assignments to assess occupational units

The centre devised assignments **must** be made up of **three** sections:

1 Assessor's Guidance Notes

This section is intended for use by the assessor only. It should contain

- a health and safety statement
- the location of where the assignment should be taken
- the requirements for tools, equipment, materials and data
- notes on the content of the assignment to include any preparatory work required by the assessor/centre
- details of evidence and recording requirements
- time consideration.

Any new assignments set must have the same time allocated to the completion of the assignment as set in the guidance note in the assignment template.

2 Candidate's Instructions

The candidate's instructions should contain:

- general advice to candidates about the need to understand the assignment before starting work and the need to seek guidance if clarification is required
- guidance on the time limits
- the importance of health and safety
- an assignment brief which sets the scene or a scenario to contextualise the task(s)
- clearly defined tasks covering a range of practical activities – an outline of each task should be provided rather than a series of marking checklists
- recording/report sheets for recording the progress of the activity
- notes which refer to how the evidence they produce should be stored and labelled.

3 Mark scheme (see Guidance for marking section on pages 11 and 12)

2.5.4 Fault diagnosis

Centres may find it difficult to arrange a 'live' fault diagnosis assignment opportunity. Centres may arrange for a realistic 'fault scenario' to be used with permission from their external verifier.

NOTE:
Where the use of drawings/specifications is essential for the activity, relevant pages can be photocopied from workshop manuals, etc – copyright and industrial confidentiality permitting. It is not usually necessary for such items to be copied out by the candidates, however, the use of sketches to show specific, important aspects of the work undertaken: eg points of wear, location of components within a system, alignment methods, etc should be encouraged.

CAD and word processing packages can be used but time spent on the presentation should not be excessive. The final grade awarded will not necessarily depend upon presentation provided the candidates' work is clear, neat and technically correct. Candidates generating evidence for IT Key Skills may wish to spend more time on this aspect of their work.

2.5.5 Submission of assignments

All centre devised assignments **must** be approved for use by a City & Guilds External Verifier.

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The Award
For the award of a certificate, candidates must successfully complete the assessments for Unit 1 plus the assessments for **two** occupational units.

Core units		**Assessment components required**	
Unit 1	Application of Health and Safety and Electrical Principles	2330-301	On-line multiple choice
Occupational units			
Unit 2	Installation (Buildings and Structures) Inspection, Testing and Commissioning	2330-302	Assignment
Unit 3	Installation (Buildings and Structures) Fault Diagnosis and Rectification	2330-303	Assignment
Unit 4	Electrical Maintenance Inspection, Testing and Commissioning	2330-304	Assignment
Unit 5	Electrical Maintenance Fault Diagnosis and Rectification	2330-305	Assignment
Unit 6	Instrumentation Inspection Testing and Commissioning	2330-306	Assignment
Unit 7	Instrumentation Fault Diagnosis and Rectification	2330-307	Assignment
Unit 8	Highway Electrical Systems Inspection Testing and Commissioning	2330-308	Assignment
Unit 9	Highway Electrical Systems Fault Diagnosis and Rectification	2330-309	Assignment
Unit 10	Panel Building Inspection Testing and Commissioning	2330-310	Assignment
Unit 11	Panel Building Fault Diagnosis and Rectification	2330-311	Assignment
Unit 12	Electrical Machine Inspection Testing and Commissioning	2330-312	Assignment
Unit 13	Electrical Machines Rewind & Repair	2330-313	Assignment

Registration and certification
Candidates must be registered at the beginning of their course. Centres should submit registrations using Form S (Registration), under scheme/complex no 2330-03

When assignments have been successfully completed, candidate results should be submitted on Form S (Results submission). Centres should note that results will **not** be processed by City & Guilds until verification records are complete.

Written tests are available through the GOLA electronic on-line assessment system.

Full details on all the above procedures will be found on the City & Guilds web site http://www.cityandguilds.com

Relationship to N/SVQ

Core Unit

Unit	Outcome		Unit of S/NVQ for which knowledge and understanding is covered
1	1	Comply with Statutory Regulations and organisational requirements	This is a generic outcome which can relate to any unit where there is a reference to health and safety regulations and other relevant legislation Specific units are 18; 18a; 18d; 81; 81a and 81d
	2	Apply safe working practices and follow accident and emergency procedures	This is a generic outcome which can relate to any unit where there a reference to health and safety. Specific units are 18; 18a; 18d; 81; 81a and 81d
	3	Effective working practices	This is a generic outcome which can relate to any unit where there is a reference to effective working.
	4	Understand the functions of electrical components	This is a generic outcome and can relate to any unit where there is a requirement for electrical principles and theory
	5	Understand electrical supply systems, protection and earthing	As outcome 4
	6	Understand the functions of electrical machines and motors	As outcome 4
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
2	1	Use safe, effective and efficient working practices to complete electrical installations	Units 18, 41and 45
	2	Select appropriate working methods and use tools, equipment and instruments for inspection testing and commissioning	

Unit	Outcome		Unit of S/NVQ for which knowledge and understanding is covered
3	1	Use safe, effective and efficient working practices to undertake fault diagnosis	Unit 54
	2	Carry out commissioning to restore systems, components and equipment to working order.	Unit 45
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
4	1	Use safe, effective and efficient working practices to undertake electrical maintenance	Unit 40
	2	Select appropriate working methods and use tools, equipment and instruments for inspection, testing and commissioning	Unit 50
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
5	1	Use safe, effective and efficient working practices to undertake fault diagnosis	Unit 54
	2	Carry out commissioning to restore systems, components and equipment to working order	Unit 50
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
6	1	Use safe effective and efficient working practices to complete instrumentation installation	Unit 15
	2	Select appropriate working methods and use tools equipment and instruments for installation and commissioning	Unit 42
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
7	1	Use safe effective and efficient working practices to undertake fault diagnosis	Unit 54
	2	Carry out commissioning to restore systems, components and equipment to working order	Unit 42
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
8	1	Use safe effective and efficient working practices to complete highway electrical systems	Unit 61
	2	Select appropriate working methods and use tools, equipment and instruments for installation and commissioning.	Unit 63
Unit	**Outcome**		**Unit S/NVQ for which knowledge and understanding is covered**
9	1	Use safe, effective and efficient working practices to undertake fault diagnosis	Unit 54
	2	Carry out commissioning to restore systems, components and equipment to working order	Unit 63
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**

10	1	Use safe effective and efficient working practices to complete panel building and installation	Unit 27
	2	Select appropriate working methods and use tools, equipment and instruments for installation and commissioning.	Unit 46
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
11	1	Use safe effective and efficient working practices to undertake fault diagnosis	Unit 54a
	2	Carry out commissioning to restore systems, components and equipment to working order.	Unit 46
Unit	**Outcome**		**Unit of S/NVQ for which knowledge and understanding is covered**
12	1	Use safe effective and efficient working practices to complete electrical installations	Unit 26
	2	Select appropriate working methods and use tools, equipment and instruments for installation and commissioning.	Unit 39
Unit	**Outcome**		**Unit S/NVQ for which knowledge and understanding is covered**
13	1	Use safe, effective and efficient working practices to undertake repair and rewind	Unit 26, 28
	2	Carry out commissioning to restore machines to working order	Unit 39

Test Specification
The assessment will be by unit. The core unit will be assessed by a multiple choice test. This will be available on-line through the GOLA system. The occupational units will be assessed by practical assignments which will include a test of underpinning knowledge.

Core Unit

Paper 301: Application of health and safety and electrical principles			
Test duration 1 hour (40 item multiple choice)			
Unit	**Outcome**		**No of questions**
1A	1	Comply with Statutory Regulations and organisational requirements	7
	2	Apply safe working practices and follow accident and emergency procedures	6
	3	Work effectively and develop competences	3
Total			16
1B	4	Understand the functions of electrical components	8
	5	Understand electrical supply systems, protection and earthing	8
	6	Understand the functions of electrical machines and motors	8
Total			24
		Overall Total	40

In order to pass the above on-line test, candidates will be required to correctly answer a proportion of both sections 1A and 1B.

Occupational unit underpinning knowledge tests

Inspection, testing and commissioning – all occupational routes					
Test duration 2 Hours (16 questions)					
Unit 2	**Outcomes**		**Weighting of Assignment and test questions**		
			Min	Max	Ques.
2, 4, 6, 8, 10, 12	1	Use safe, effective and efficient working practices to complete installations/assemblies	30	40	6
	2	Select appropriate working methods and use tools, equipment and instruments for installation and commissioning	60	70	10

Fault diagnosis and rectification – all occupational routes					
Unit 3	**Outcomes**		**Weighting of assignment and test questions**		
			Min	Max	Ques.
3, 5, 7, 9, 11, 13	1	Use safe, effective and efficient working practices to undertake fault diagnosis	40	60	10
	2	Carry out commissioning to restore systems, components and equipment to working order.	40	60	6

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Key Skills Signposting

The aim is to extract evidence of the required key skills from within the natural context of the technical aspects of work. However in order to meet some of the requirements it may be necessary to extend the normal recording/documentation activities. It is unlikely that all of the requirements can be met in this way and additional opportunities by means of tasks/projects will be provided by your tutor/trainer. In order to achieve success at this level the candidate must meet **all** of the requirements as specified in the key skills publication. Note that these documents also provide useful additional information and guidance to help with the production of evidence.

The following reference table shows where suitable evidence could be obtained, but note

- it is not necessary to provide examples of evidence from every unit that you undertake
- not all of the unit elements can be obtained, and so a complete list of the unit elements is given.

If producing certain types of evidence for some units creates difficulties because of disability or other factors, you may be able to use other ways to show your achievement. Ask your supervisor for further information.

Information Technology
IT 2.1 Search for and select information
IT 2.3 Present information

Communication
C2.1a Contribute to a group discussion
C2.1b Give a short talk.
C2.2 Read and summarise information
C2.3 Write documents

Application of number
N1.3 Interpret results and present finding
N2.1 Interpret information.
N2.2 Carry out calculations

Identification of Key Skills - Summary relationship table

Unit Number and title	Communication	Application of number	Information Technology
1 Application of health and safety and electrical principles	C2.1 C2.2	N2.1 N2.2	IT 1.1
2 Installation (Buildings and Structures) Inspection, testing and commissioning	C2.1 C2.2 C2.3	N 2.1 N 2.2 N2.3	IT1.1 IT1.2
3 Installation (Buildings and Structures) Fault diagnosis and rectification	C2.1 C2.2	N2.1 N2.2	IT 2.1

Unit Number and title	Communication	Application of number	Information Technology
4 Electrical maintenance inspection testing and commissioning	C2.1 C2.2	N2.1 N2.2 N2.3	
5 Electrical maintenance inspection fault diagnosis and rectification	C 2.2	N2.1	
6 Instrumentation inspection testing and commissioning	C 2.2	N2.1 N2.2 N2.3	
7 Instrumentation fault diagnosis and rectification	C 2.2	N 2.1	
8 Highway electrical systems inspection testing and commissioning	C 2.2	N2.1 N2.2 N2.3	
9 Highway electrical systems fault diagnosis and rectification	C 2.2	N2.1	
10 Panel building inspection, testing and commissioning		N2.1 N2.2 N2.3	IT2.1
11Panel building fault diagnosis and rectification			
12 Electrical machines, inspection testing and commissioning	C2.2 C2.3	N2.1 N2.2 N2.3	IT2.1
13 Electrical machines repair and rewind	C1.1 C2.2 C2.3		IT 1.1

Grading descriptors

Practical assignments		
Pass	**Credit**	**Distinction**
In a practical activity, involving some non-routine operations the candidate demonstrated the use of skills in meeting the essential requirements of the outcomes of the unit	In a practical activity, involving some non-routine operations the candidate demonstrated the use of skills in meeting the substantial majority of requirements of the outcomes of the unit	In a practical activity, involving some non-routine operations the candidate demonstrated the use of skills in meeting the comprehensive requirements of the outcomes of the unit
Written tests		
Pass	**Credit**	**Distinction**
The candidate achieved 50% of the marks available (48/96)	The candidate achieved 65% of the available marks (62/96)	The candidate achieved 80% of the available marks (76/96)

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Identification of opportunities for evidence generation of moral, ethical, spiritual, European dimension, Environmental education and Health and safety

Unit No and Title	Moral, Ethical and Spiritual	European dimension	Environmental education	Health and safety
1 Application of health safety and electrical principles	1.3	1.1	1.1	1.1 1.2
2 Installation (Buildings and Structures) Inspection testing commissioning				2.1
3 Installation (Buildings and Structures) Fault diagnosis and rectification				3.1
4 Electrical maintenance inspection testing commissioning				4.1
5 Electrical maintenance fault diagnosis and rectification				5.1
6 Instrumentation inspection testing commissioning				6.1
7 Instrumentation fault diagnosis and rectification				7.1
8 Highway electrical systems inspection testing commissioning				8.1
9 Highway electrical systems fault diagnosis and rectification				9.1
10 Panel building inspection testing commissioning				10.1
11 Panel building fault diagnosis and rectification				11.1
12 Electrical machines inspection testing commissioning				12.1

13 Electrical machines repair and rewind				13.1

Employment rights and responsibilities matrix

ERR	Scheme handbook reference
Employment law	
Statutory rights	1.1, 1.3
Procedures and documentation	
Sources of information and advice	
Organisation and representation	
Organisation of the industry and how the job fits in	
Jobs, roles and careers	1.3
Representation in the industry	
Sources of information and advice	
Industry issues	
Principles and codes of practice	Identified within each optional unit
Issues of public concern	

Unit 1 - 301 Application of health and safety and electrical principles

Rationale

The aim of this core unit is to recognise the importance of the candidate's ability to work safely and efficiently and to understand the electrical principles which allow electrotechnical activities to be carried out. It includes responsibilities, accident reporting and the identification of hazards and risks. It also covers the competencies needed to work efficiently and effectively in the working environment including the efficient use of resources, the creation and maintenance of effective working relationships with colleagues and line management, the setting and review of objectives and targets for personal development and contribution to opportunities for improvement to working practices and procedures.

There are six learning outcomes to this unit. The candidate will be able to

1 comply with statutory regulations and organisational requirements
2 understand safe working practices and follow accident and emergency procedures
3 understand effective working practices
4 understand the functions of electrical components
5 understand electrical supply systems, protection and earthing
6 understand the functions of electrical machines and motors

Connection with other awards

This core unit combines with the optional occupational units to underpin the technical requirements needed in a range of electrotechnical activities. This unit relates to the NET units at level 3

Assessment

1 *Practical Activities*
There is no formal practical assessment for this unit but candidates will be expected to demonstrate the skills learnt within the occupational unit assessment

2 *Written Tests*
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification and delivered through the online assessment system.

Outcome 1 Comply with statutory regulations and organisational requirements

Practical Activities

The candidate will be able to

1 select appropriate Personal Protective Equipment (PPE) and safety equipment for a designated task
2 recognise a series of warning, prohibition and mandatory safety signs
3 complete an accident report
4 carry out and prepare a risk assessment.

Underpinning Knowledge

The candidate will be able to

1 identify basic safety regulation awareness applicable to electrotechnical operations
   a Health and Safety at Work Act 1974
   b Electricity at Work Regulations 1989
   c Control of Substances Hazardous to Health Regulations 1999
   d Provision and use of Work Equipment Regulations 1998
   e Portable Appliance Testing Regulations
   f Control of Major Accident and Hazards Regulations 1999
   g Noise and Statutory Nuisance Act 1993
   h Noise Act 1996
   i Reportable Diseases and Dangerous Occurrences Regulations (RIDDOR) 1985
   j Management of Health and Safety Regulations 1998

2 state employers' responsibilities to maintain safety in terms of providing
   a a safe place of work
   b safe plant and equipment
   c a safe system of work
   d a safe working environment
   e safe methods of handling, storing and transporting goods and materials
   f reporting of accidents
   g information, instruction, training and supervision of employees
   h a safety policy

3 describe essential operator and bystander safety requirements
   a Personal Protective Equipment (PPE)
   b Respiratory Protective Equipment (RPE)
   c secure areas, e.g. notices, barriers

4 describe the implementation within individual organisations of
   a safety policies
   b codes of practice
   c safe working practices and procedures

5 recognise safety signs designated
   a Warning
   b Prohibition
   c Mandatory

6 outline the roles, responsibilities and powers of
   a Safety Officers
   b Safety Representatives
   c Health and Safety Executive Inspectors
   d Environmental Health Officers

7 explain where to access and the sources of Health and Safety literature/advice

8 describe the human and environmental conditions leading to accidents in the working environment and the means of controlling them
   a causes of accidents
      i human: carelessness; improper behavior and dress; lack of training, supervision and experience; fatigue; drug-taking and drinking
      ii environmental: unguarded or faulty machinery or tools; inadequate ventilation; untidy, dirty, overcrowded, badly-lit workplaces
   b accident prevention measures
      i eliminate the hazard
      ii replace the hazard with something less dangerous
      iii guard the hazard
      iv personal protection
      v safety education and publicity

9 describe the procedures for reporting accidents
   a summary of what happened
   b name of victim
   c summary of events prior to accident
   d details of witnesses
   e information on injury or loss sustained
   f conclusions
   g recommendations
   h supporting material
      i photographs
      ii video
      iii diagrams
   i date
   j signature of person(s) responsible for report

10 describe how to carry out a risk assessment and prepare a report identifying potential health hazards.
   a slippery or uneven surfaces
   b spillages
   c scrap or waste material
   d inflammable materials
   e faulty or missing machine guards
   f faulty electrical connections or damaged cables
   g material ejection
   h pressure and stored energy
   i unshielded processes
   j volatile and toxic materials
   k dust and fumes
   l contaminants and irritants
   m materials handling and transportation
   n working at heights

11 describe the procedures used to notify/report hazards to appropriate people
- a supervisors
- b safety officers or representatives
- c fire officers
- d works rescue team

12 explain environmental management systems (BSEN ISO 14001) in terms of the electrotechnical industry

13 describe briefly environmental legislation as it applies to electrotechnical industries
- a Environmental Protection Act 1990
- b Pollution Prevention and Control Act 1999
- c Clean Air Act 1993
- d Radioactive Substances Act 1993
- e Controlled Waste Regulations 1998
- a) Dangerous Substances and Preparations and Chemicals Regulations 2000

14 list factors within the electrotechnical sector causing change, and describe their influence on working patterns and training needs
- a list factors causing change in terms of
  - i changing demand
  - ii increased scale of competition
  - iii competitiveness in terms of
    - 1 marketing
    - 2 productivity
    - 3 quality
  - iv introduction of new technology
- b describe effects of change on working patterns and practices in terms of
  - i broad-based skill requirement
  - ii transferable skill requirement
  - iii increased technological content of job
  - iv changeable and flexible working
  - v demand for increased organizational cohesiveness
  - vi need for continual retraining and updating
  - vii expectation of more frequent job change
  - viii development of new career patterns

15 describe the importance, for continued trading, of maintaining good customer relations, and outline measures designed for customer protection
- a describe the importance of meeting customer expectations in terms of
  - i product/service 'fitness for purpose'
    - 1 performance
    - 2 cost
  - ii agreed completion dates
  - iii reliability
- b outline the legal obligations of a sales contract

Outcome 2 Apply safe working practices and follow accident and emergency procedures

Practical Activities

The candidate will be able to

1 recognize potential safety hazards within the workplace
2 identify the location of first aid facilities within the workplace
3 outline emergency evacuation procedures at the workplace
4 identify possible sources of fire within the workplace
5 identify types of fire extinguisher and match them with various types of fires

Underpinning Knowledge

The candidate will be able to

1 outline the necessity of a permit to work/enter procedure

2 outline the necessity of 'lock-off' procedures

3 describe situations in which it is unadvisable or unsafe to work in isolation
   a in confined spaces
   b above ground or in trenches
   c in close proximity to unguarded machinery
   d when a fire risk exists
   e with toxic or corrosive substances

4 describe the need for the provision of First Aid treatment
   a location of facilities
   b location of qualified first aiders

5 describe the safety procedures to prevent injury or discomfort to own or colleagues' skin, eyes, hands and limbs
   a personal hygiene, skin protection and care; care of eyes
   b the use of eye and face protectors which are to current EN specifications; use of respirators
   c the dangers of hair and loose clothing getting caught in machinery and the means of avoiding such dangers; the benefits and use of protective clothing
   d the use of safety guards, screens and fences

6 describe the appropriate emergency action to be taken in case of electric shock
   a isolate electrical supply
   b removal from electricity supply
   c basic resuscitation procedures

7 describe precautions against electric shock
   a hazards arising from the use of electrical equipment
   b general safety rules: checking and inspection of cables, leads and plugs; earthing; problems associated with the use of portable equipment; use of reduced voltage equipment
   c safety training, warning signs and notices
   d isolation procedures

8 outline the causes of asphyxiation and the appropriate emergency action to be taken
   a confined working spaces
   b inadequate ventilation

9 define what is meant by a
    a dangerous occurrence
    b hazardous malfunction

10 describe the procedures to be taken in the event of the sounding of an emergency alarm
    a evacuation system
    b escape routes including alternatives
    c assembly points
    d ‘reporting in’ at assembly points
    e not to return until authorised

11 describe methods of fire prevention and methods of controlling fires
    a conditions required for combustion and extinction
        i causes of fire
        ii spread of fire
        iii fire prevention
    b fire procedures
        i fire drills
        ii fire fighting equipment for different types of fires
            1 extinguishers
            2 automatic equipment
        iii fire protection legislation

Outcome 3 Understand effective working practices

Underpinning Knowledge

The candidate will be able to

1 a identify learning and the relation to personal performance
  b outline the career patterns in the electrotechnical sector and the education and training opportunities for entry, promotion and transfer

2 explain the features of teamworking
  a storming
  b forming
  c norming
  d performing

3 explain employment legislation within the electrotechnical industry in terms of the rights and responsibilities of personnel
  a Employment Rights Act 1996
  b Data Protection Act 1998
  c Disability Discrimination Act 1995
  d Race Relations Act 1976
  e Race Relations (Amendment) Act 2000
  f Sex Discrimination Act 1975
  g Human Rights Act 1998

4 explain that to carry out electrotechnical tasks safely and efficiently the process should involve
  a checking the instructions and specifications
  b checking the work area for suitability
  c determining the sequence of operations
  d determining the tools and equipment required
  e assessing the skills required
  f co-ordinating the functions of associated trades
  g observing safety procedures and practices
  h checking completed task meets specification

5 explain the standards for assessing working practices and procedures
  a ISO 9000
  b Investors in People

6 outline the benefits of improving working practices and procedures
  a customer satisfaction
  b improved productivity
  c more efficient use of resources
  d increased profitability

Outcome 4 Understand the functions of electrical systems/components

Underpinning knowledge

The candidate will be able to

1 describe resistors
   a define the term resistance, state that resistance depends on the dimensions, type of material and temperature, define resistivity
   b state the relationship between the resistance of a conductor and its length, cross-sectional area and its resistivity
   c determine the current, voltage, resistance and power in simple series and parallel circuits using Ohm's Law; calculate the power dissipated

2 describe magnetism and magnetic circuits
   a define magnetic fields
   b state that magnetic fields are considered to consist of lines of magnetic flux
   c state the rules applicable to lines of magnetic flux
   d identify the flux paths of typical magnetic circuits
   e state the relationship between magnetic flux, cross-sectional area and magnetic flux density

3 describe inductance and inductive components
   a describe inductors as wound components
   b state how an electric current may be generated by dynamic or static induction
   c define magnetic flux
   d explain the difference between self and mutual induction
   e determine the emf of self or mutual induction, given the
      i inductance and change of rate of current
      ii number of turns and rate of change of flux
      iii rate of cutting flux by conductor
   f relate inductive components in electrical machines (e.g. field coils, transformer winding)
   g determine the force on a current carrying conductor in a magnetic field using F=BIL

4 describe capacitors
   a define capacitance the electrical field, electric stress, dielectrics; relate potential difference, charge and capacitance
   b identify the constructional features of different types of capacitor; parallel plate, variable and semi-variable air spaced, solid dielectric
   c state the dangers associated with capacitors

5 a state the effects of resistance, inductance, capacitance and impedance in a.c circuits
   b determine values of X_C, X_L, R and Z in a.c circuits
   c determine power developed (or dissipated) in single phase circuits
      i using V, I and power factor
      ii state the average power in a
         A resistor is VI
         B pure inductance is zero
         C pure capacitance is zero

6 describe semiconductor devices
- a describe the action of semiconductor devices in simple rectifier circuits
  - i state that the diode is a device which allows current to flow in one direction
  - ii define PIV
  - iii state that the conduction in a thyristor(SCR) is controlled by a gate electrode
  - iv recognise circuits and input/output waveforms for half wave, full wave and bridge circuits
- b describe the action of a transistor when used
  - i as a switch
  - ii as an amplifier

7 describe basic electronic circuits and components
- a identify listed components from their packaging
  - i resistor
  - ii capacitor
  - iii transistor
  - iv diode
  - v integrated circuit
- b state the use of the following
  - i photocell
  - ii photodiode
  - iii phototransistor
  - iv optocoupler
  - v infra red source and sensor
  - vi fibre optic link
  - vii solid state temperature device

8
- a describe luminaire components
  - i incandescent lighting
  - ii discharge lighting
- b understand the application of
  - i inverse square law
  - ii cosine law
  - iii lumen method of calculation

Outcome 5 Understand electricity supply systems, protection and earthing

Underpinning Knowledge

The candidate will be able to

1 describe electricity supply systems
- a distinguish between, and state the function of, transmission and distribution systems
- b list the stages in power supply
  - i generation
  - ii super grid
  - iii grid substation
  - iv local substation
- c state how power stations are interconnected and list the advantages of the interconnection
- d state the reasons for high voltage transmissions
- e with reference to the systems listed at b) i) – iv) above, state
  - i the standard voltages used
  - ii the voltages at which specific consumer groups are supplied
  - iii the effects of voltage drop and losses and carry out simple calculations
- f describe how single phase, three phase three wire and three phase four wire systems are produced from a three phase generator
- g use circuit diagrams to identify loads connected in star and delta
- h identify and calculate line and phase values of voltage and current in three phase star and delta connected balanced systems
- i determine the power in three phase balanced loads using 3VI x power factor
- j determine in a three-phase system the values of
  - i kW
  - ii kVA
  - iii kVAr
  - iv Power Factor
  - v Neutral Current

2 describe industrial distribution systems
- a list industrial type distribution systems and state typical applications
  - i flexible and rigid conduits
  - ii trailing cables and overhead collectors
  - iii busbar trunking
  - iv underfloor trunking/ducting
  - v cable trunking
  - vi rising mains
  - vii PILCSWA, PVCSWA and MIMS/MICC cables
  - viii LSF cables
  - ix FP 200

3 describe transformers
- a state the principle of operation of transformers
- b state the relationship between input, output and losses
- c perform simple calculations on input, output and losses
- d perform calculations involving current, voltage and turns for ideal transformers
- e explain the term ‘rating of a transformer’ and the reason for rating in kVA
- f determine the maximum line current of a three phase transformer from kVA rating
- g describe auto transformers and state associated danger

4 describe switchgear (both LV and HV)
- a state the function of listed switchgear
  - i circuit breakers
  - ii switches
  - iii isolators

5 describe earthing systems
- a state the reasons for earthing
  - i low voltage systems
  - ii high voltage systems
- b identify typical systems

6 describe protection systems
- a list the abnormal conditions for which protection systems need to be provided
  - i dangerous currents due to short circuits
  - ii earth leakage
  - iii overload
- b state methods of protection to counteract abnormal conditions listed at a)
  - i fuses
  - ii circuit breakers
  - iii residual current devices
  - iv RCBOs

Outcome 6 Understand the functions of electrical machines and motors

Underpinning Knowledge

The candidate will be able to

1 describe the principles of operation of electrical rotating machines
   a state the principles of operation of the alternating current generator
   b describe the principle of operation of unidirectional current generators including the function of the commutator
   c describe the interdependence of frequency, speed, pole pairs, emf, speed and magnetic fields strength
   d describe the principle of operation of the d.c machine as a motor and a generator
   e describe the production of a rotating magnetic field from a three-phase supply

2 identify three phase induction motors, distinguish between
   a cage rotor
   b wound rotor

3 identify single phase a.c motors (rated below 1kW) distinguish between
   a series wound
   b split phase
   c capacitor
   d capacitor start\run

4 identify basic principles of
   a starting
   b speed control

Unit 2 – 302 Installation (Buildings and Structures) Inspection, testing and commissioning

Rationale

This unit identifies the principles and processes applicable to the inspection, testing and commissioning of electrical installations. The content of this unit covers procedures for inspection, testing to meet the requirements of the installation and the industry codes of practice.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to complete electrical installations
2 select appropriate working methods and use tools, equipment and instruments for installation and commissioning

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Use safe, effective and efficient working practices to complete electrical installations

Practical Activities

The candidate will be able to

1 identify and determine all procedures and equipment to install and connect an electrical installation in accordance with relevant codes of practice and regulations
2 obtain the necessary clearances or approvals for the work to be undertaken
3 connect and complete an electrical installation in accordance with relevant codes of practice, procedures and regulations

Underpinning knowledge

The candidate will be able to

1 describe the methods and procedures necessary to make an area safe before starting work by
   a using barriers and/or tapes
   b placing warning signs in appropriate positions
   c informing any persons who may be affected
   d isolating power
   e obtaining official clearance (Permit to Work)

2 describe the general types of work that need to be included in installation activities
   a installing electrical equipment and systems into new sites or locations
   b replacement of electrical equipment or extending facilities

3 state the factors that need to be considered when planning an installation
   a site conditions and locations of components
      i structure – component parts, access,
      ii building fabric
      iii external influences
   b storage of parts and materials
   c tools and equipment
   d minimising disruption to adjacent work areas
   e how to estimate the length of time needed for the installation

4 identify the parties concerned with installations and their relationships
   a client
   b main-contractor
   c sub-contractor
   d suppliers
   e consultants

5 state the role of relevant parties with respect of regulatory requirements
   a Building regulations
   b environmental
   c health and safety
   d electrical regulations

6 read and interpret drawings and specifications to prepare requisitions
   a site plans
   b block diagrams
   c location diagrams
   d circuit diagrams

7 state procedures involved with producing a formal contract and the role of contracts in installation activities

8 state the use of the following to monitor contract progress
- a bar charts
- b critical path networks
- c site records
- d site diaries
- e variation orders

9 explain the importance of
- a coordinating electrical installation contracts with other trades
- b recognising the implications of variations

10 explain the importance of effective communication to maintain good relationships with
- a customer/client
- b architect
- c surveyor
- d main contractor
- e local authorities representatives
- f colleagues and other trades

11 state the supplier's standard voltages for transmission and distribution

12 describe the single and three phase four wire systems of distribution and the importance of load balancing

13 describe arrangements for electrotechnical systems in respect of
- a isolation and switching
- b overcurrent protection
- c earth fault protection

14 state the dangers associated with the use of electricity and describe methods of controlling risk with reference to
- a isolation and switchgear
- b direct and indirect contact
- c installation terminals
- d location of equipment and components

15 identify appropriate wiring systems and enclosures for installations with reference to
- a use of the structure
- b environmental conditions
- c current demand
- d overcurrent protection

16 describe the advantages and limitations of common wiring systems and enclosures
- a wiring systems
  - i mims
  - ii pvc/swa cable
  - iii pvc single core
  - iv pvc twin and earth
  - v fire retardant cable
- b wiring enclosures
  - i pvc and steel conduit
  - ii pvc and steel trunking
  - iii cable tray and ladder
  - iv ducting systems

17 state the conditions for effective termination of wiring systems cables and conductors
   a electrically and mechanical sound
   b ability to carry design current
   c prevention of corrosion

18 state the factors affecting selection of conductor size as
   a design current
   b voltage drop
   c regulations concerning thermal constraints and shock protection

19 carry out calculations to select appropriate conductor size that includes
   a determining design current
   b applying correction factors and diversity
   c determining voltage drop
   d determining protective device
   e applying regulations concerning thermal constraints and shock protection

20 explain the need to refer to the time/current characteristics within BS7671 or other published data in order to determine disconnection times

21 determine the size of conduit appropriate to the size and number of cables

22 explain the terms
   a earthing
   b bonding

23 describe system earthing arrangements to include TT, TN-S, TNC-S and TN-C

24 describe the applications and limitations of installation protective equipment
   a overcurrent devices
   b fuses
   c circuit breakers
   d residual circuit breakers

25 describe the installation of consumers' switchgear

Outcome 2 Select appropriate methods and use tools, equipment and instruments for inspection, testing and commissioning

Practical Activities

The candidate will be able to

1 determine appropriate procedures for inspection and testing of electrical installations and the related systems, components and equipment
2 demonstrate safe and efficient practices for inspection
3 select and use instruments for testing and commissioning purposes.

Underpinning knowledge

The candidate will be able to

1 state the purpose of inspection and commissioning and the factors to considered
  a process as part of the initial verification procedure for a new installation
    i complies with Regulations
    ii meets specification
    iii safe to use
  b factors to be considered
    i safety precautions - assessment of safe working practices, permit to work , isolation
    ii purpose and usage of systems and equipment – identification of circuits, equipment
    iii test procedures – test instruments, correct methods
    iv sources of information – relevant data, accurate labelling, recording
    v contact with relevant parties – customers/clients,

2 identify the purpose and conditions for periodic inspection
  a change of use of building/premises
  b alterations/additions to electrical systems
  c damage to electrical systems

3 list relevant sources of information to facilitate inspection and testing
  a IEE Wiring Regulations BS:7671
  b contract specifications
  c distribution/wiring diagrams
  d manufacturers instructions
  e relevant statutory legislation

4 list the items associated with visual inspection prior to commissioning
  a main intake/switchboard connections
  b power circuits
  c lighting circuits
  d conduit, trunking, traywork
  e components

5 identify and select instruments suitable for testing and commissioning
  a voltage indicating device and proving unit
  b low-resistance ohmmeter /continuity tester
  c insulation resistance tester
  d earth electrode resistance tester
  e earth fault loop impedance and PSCC/PFC tester
  f RCD tester
  g clamp meters (tong testers)

6 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

7 describe how to carry out tests for
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f operation of RCD
   g functional testing

8 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

9 describe the certification process for a completed installation
   a responsibilities of relevant personnel
   b documentation
      i Electrical Installation Certificate
      ii Schedule of Inspections
      iii Schedule of Test Results
      iv Minor Works Certificate

10 describe the requirements of inspection testing with reference to
   a types of test equipment
   b sequence and procedures for tests
   c application of BS 7671

11 describe procedures for dealing with
   a report forms and documentation
   b customer/client

Unit 3 – 303 Installation (Buildings and Structures) Fault diagnosis and rectification

Rationale

This unit identifies the principles and processes applicable to fault diagnosis on systems, equipment and components within an electrical installation. The content of this unit covers safe and approved procedures for fault finding and the re-establishment of operational conditions.

There are two outcomes to this unit. The candidate will be able to

1. use safe, effective and efficient working practices to undertake fault diagnosis
2. carry out commissioning to restore systems, components and equipment to working order

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Select and apply fault diagnosis and rectification techniques

Practical Activities

The candidate will be able to

1 utilise safe methods for undertaking fault diagnosis
2 determine faults in electrotechnical systems and equipment

Underpinning knowledge

The candidate will be able to

1 identify electrotechnical systems and equipment utilising single and three phase supply within installations for
   a power circuits
   b lighting
   c control systems
   d components

2 state the safe working procedures to be applied before undertaking fault diagnosis
   a on load, off load isolating devices are identified and operated
   b voltage indication equipment is 'proved' prior to verifying effective isolation
   c isolation device secured in OFF position
   d warning notices posted
   e all relevant safety and functional checks are completed prior to restoration of supply

3 state the basic principles of undertaking fault finding as
   a knowledge and understanding of relevant electrotechnical systems and equipment
   b optimum use of personal and others experience and expertise of systems and equipment
   c use of a logical approach

4 list and describe the stages of logical fault diagnosis and rectification
   a collection and collation of data
      i information on events leading up the fault
      ii information from verbal and written reports
   b analysis of evidence and use of standard tests to diagnose cause of faults
   c interpretation of test results
   d functional checks and test to verify rectification and restoration as per appropriate regulations

5 list circumstances where faults may occur in an electrotechnical system
   a wiring
   b cable terminations
   c accessories/controls (eg switches, switchgear, contactors, electronics)
   d instrumentation/metering
   e protective devices
   f luminaries
   g flexible cable/cords
   h components

6 describe typical symptoms as
   a complete loss of supply at origin
   b localised loss of supply
   c overload or fault current devices operating
   d transient voltages
   e insulation failure
   f component failure

7 describe the factors which influence repair or replacement
   a costs
   b availability of replacement
   c downtime under fault condition
   d legal responsibility – warranties

8 state the factors which may effect rectification
   a access to system/equipment
   b provision of emergency/standby supply
   c client demand for continuous supply

9 recognise situations where special precautions should be applied
   a fibre optic cabling
   b antistatic precautions
   c damage to electronic devices by ‘over voltage’
   d avoidance of shut down for IT equipment
   e risk of high frequency or large capacitive circuits
   f presence of storage batteries

Outcome 2 Select appropriate methods and use tools, equipment and instruments to restore systems equipment and components to working order

Practical Activities

The candidate will be able to

1 apply rectification techniques
2 determine appropriate procedures for re commissioning of electrical installations and the related systems, components and equipment
3 demonstrate safe and efficient practices
4 restore system, equipment, component to working order

Underpinning knowledge

The candidate will be able to

1 list relevant sources of information to facilitate re-commissioning
   a IEE Wiring Regulations
   b contract specifications
   c distribution/wiring diagrams
   d manufacturers instructions
   e relevant statutory legislation

2 describe the requirements of testing and commissioning with reference to
   a types of test equipment
   b sequence and procedures for tests
   c application of the current Wiring Regulations

3 describe procedures for dealing with
   a report forms and documentation
   b customer/client

4 select instruments suitable for fault diagnosis and rectification
   a voltage indicating device and proving unit
   b low-resistance ohmmeter /continuity tester
   c insulation resistance tester
   d earth electrode resistance tester
   e earth fault loop impedance and PSCC/PFC tester
   f RCD tester
   g tong testers/clamp meters

5 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

6 describe how to carry out functional checks and tests to verify rectification and restoration of system and equipment including as appropriate
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f) operation of RCD
   g functional testing

7 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

8 state the necessity for advising the customer/client of the need for additional restoration work to building fabric as required
   a brickwork
   b plastering
   c decorating

9 list procedures for the disposal of waste materials and leaving site in a safe and clean condition

10 describe the process for completion after rectification in terms of
   a responsibilities of relevant personnel
   b documentation

Unit 4 -304 Electrical maintenance Inspection, testing and commissioning

Rationale

This unit identifies the principles and processes applicable to the maintenance, inspection, testing and commissioning of maintained electrotechnical systems. The content of this unit covers procedures for inspection, testing to meet the requirements of the system and the industry codes of practice.

There are two outcomes to this unit. The candidate will be able to

1. use safe, effective and efficient working practices to undertake electrical maintenance
2. select appropriate working methods and use tools, equipment and instruments for inspection testing and commissioning

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Use safe, effective and efficient working practices to undertake electrical maintenance

Practical Activities

The candidate will be able to

1 determine all procedures and equipment to undertake electrical maintenance
2 obtain the necessary clearances or approvals for the work to be undertaken
3 carry out electrical maintenance on systems, components and equipment

Underpinning knowledge

The candidate will be able to

1 describe the methods and procedures necessary to make an area safe before starting work by
   a using barriers and/or tapes
   b placing warning signs in appropriate positions
   c informing any persons who may be affected
   d isolating power
   e obtaining official clearance (Permit to Work)
   f shutting down machinery
   g isolating and securing related systems (hydraulic, air, gas, steam)
   h identifying hazardous materials

2 describe the general types of work that need to be included in maintenance activities on electrical equipment and systems
   a electrotechnical systems to include operation and control of heating ,lighting, ventilation, security, communications and process control
   b electrical equipment to include plant, components, motors, and starters, switchgear and distribution panels, control systems and components and luminaires
   c planned and preventive maintenance
      i scheduled
      ii condition based
   d corrective maintenance
   e replacement of electrical equipment or extending facilities

3 list the outcomes of electrical maintenance as
   a ensuring equipment and systems function efficiently
   b ensuring equipment and systems operate safely
   c obtaining maximum value from assets and reducing down time

4 state the factors that need to be considered when planning maintenance
   a site conditions and locations of components
      i structure – component parts, access,
      ii external influences
   b access to parts and materials
   c tools and equipment, workshop facilities
   d minimising disruption to adjacent work areas
   e how to estimate the length of time needed for the maintenance operation
   f reference data and documentation, servicing records, logs

5 identify the parties concerned with maintenance and their relationships
   a client
   b sub-contractor
   c suppliers
   d consultants

6 state the role of regulatory requirements
   a Building regulations
   b environmental
   c health and safety
   d electrical regulations

7 read and interpret drawings and specifications to prepare for maintenance
   a assembly drawings
   b block diagrams
   c location diagrams
   d circuit diagrams

8 state procedures involved with undertaking maintenance
   a work plan
      i definition of the task
      ii shut-down arrangements
      iii permits to work
      iv coordination with stores/suppliers
      v maintenance schedules/documentation
      vi communications
      vii safety precautions
      viii cost estimates
      ix time estimates
   b reporting procedures
      i system/component identification
      ii description of maintenance
      iii recommendations
      iv use of records, logs

9 explain the importance of effective communication to maintain good relationships with
   a customer/client
   b colleagues
   c team leaders, supervisors
   d other contractors
   e non-electrical operatives

10 state the suppliers' standard voltages for transmission and distribution

11 describe the single and three phase four wire systems of distribution and the importance of load balancing

12 describe arrangements for electrotechnical maintained systems in respect of
   a isolation and switching
   b overcurrent protection
   c earth fault protection

13 state the dangers associated with the use of electricity and describe methods of controlling risk with reference to
   a isolation and switchgear
   b direct and indirect contact
   c installation terminals
   d location of equipment and components

14 identify appropriate wiring systems and enclosures with reference to
   a system usage
   b environmental conditions
   c current demand
   d overcurrent protection

15 describe the advantages and limitations of common wiring systems and enclosures
- a wiring systems
  - i mims/micc
  - ii pvc/swa cable
  - iii pvc single core
  - iv thermoplastic (pvc) twin with cpc
  - v fire retardant cable
- b wiring enclosures
  - i pvc and steel conduit
  - ii pvc and steel trunking
  - iii cable tray and ladder
  - iv ducting systems

16 state the conditions for effective termination of wiring systems cables and conductors
- a electrically and mechanical sound
- b ability to carry design current
- c prevention of corrosion

17 state the factors affecting selection of conductor size as
- a design current
- b voltage drop
- c regulations concerning thermal constraints and shock protection

18 carry out calculations to
- a determine circuit current
- b determine protective device
- c apply correction factors and diversity
- d determine voltage drop
- e select appropriate conductor

19 determine the size of conduit appropriate to the size and number of cables

20 explain the terms
- a earthing
- b bonding

21 describe system earthing arrangements to include TT, TN-S, TNC-S and TN-C

22 describe the function and installation of protective equipment
- a overcurrent devices
- b fuses
- c circuit breakers
- d residual circuit breakers

23 describe the installation and maintenance of switchgear

24 describe the operating characteristics of electric motors
- a state the type of construction
- b describe starting methods
- c describe types of enclosure
- d describe the rating of motors and undertake calculations

25 list routine care and maintenance procedures for

a motors
b switchgear
c starters
d contactors
e power transmission mechanisms
f luminaries
g heating systems

Outcome 2 Select appropriate methods and use tools, equipment and instruments for inspection, testing and commissioning

Practical Activities

The candidate will be able to

1 determine appropriate procedures for inspection and testing of electrical systems, components and equipment
2 demonstrate safe and efficient practices for inspection
3 select and use instruments for testing and commissioning purposes.

Underpinning knowledge

The candidate will be able to

1 state the purpose of inspection and commissioning and the factors to considered
   a process as part of the initial verification procedure for a new installation or re commissioning of equipment or components
      i complies with Regulations
      ii meets specification
      iii safe to use
   b factors to be considered
      i safety precautions - assessment of safe working practices, permit to work , isolation
      ii purpose and usage of systems and equipment – identification of circuits, equipment
      iii test procedures – test instruments, correct methods
      iv sources of information – relevant data, accurate labelling, recording
      v contact with relevant parties – customers/clients,

2 identify the purpose and conditions for periodic inspection
   a change of use of building/premises
   b alterations/additions to electrical systems
   c damage to electrical systems

3 list relevant sources of information to facilitate inspection and testing
   a IEE Wiring Regulations
   b contract specifications
   c distribution/wiring diagrams
   d manufacturers' instructions
   e relevant statutory legislation

4 list the items associated with visual inspection prior to commissioning
   a main intake/switchboard connections
   b power circuits
   c lighting circuits
   d conduit, trunking, traywork
   e components

5 select instruments suitable for testing and commissioning
   a voltage indicating device and proving unit
   b low-resistance ohmmeter/continuity tester
   c insulation resistance tester
   d earth electrode resistance tester
   e earth fault loop impedance and PSCC/PFC tester
   f RCD tester
   g clamp meters (tong testers)

6 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

7 describe how to carry out tests for
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f operation of RCD
   g functional testing

8 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

9 describe the certification process for a completed maintenance task
   a responsibilities of relevant personnel
   b documentation
      i Electrical Installation Certificate
      ii Schedule of Inspections
      iii Schedule of Test Results

10 identify procedures to be followed before signing inspection and completion certificates including
   a ensuring that installed system complies with the specification and relevant standards
   b action to be taken to rectify any faults or omissions.

Unit 5 – 305 Electrical Maintenance Fault diagnosis and rectification

Rationale

This unit identifies the principles and processes applicable to fault diagnosis on maintained electrical systems, equipment and components. The content of this unit covers safe and approved procedures for fault finding and the re-establishment to operational conditions.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to undertake fault diagnosis
2 carry out commissioning to restore systems, components and equipment to working order

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Use safe effective and efficient working practices to undertake fault diagnosis

Practical Activities

The candidate will be able to

1 determine faults in electrotechnical systems and equipment
2 apply rectification techniques
3 restore electrotechnical systems and equipment to working order

Underpinning knowledge

The candidate will be able to

1 identify electrotechnical systems and equipment utilising single and three phase supply within installations
   a systems
      i ELV and LV single and multiphase power circuits
      ii lighting
      iii switchgear
      iv control systems
   b equipment
      i electrical plant, components and accessories
      ii motors and starters
      iii switchgear and distribution panels
      iv control systems and components
      v luminaries

2 state the safe working procedures to be applied before undertaking fault diagnosis
   a on load, off load isolating devices are identified and operated
   b voltage indication equipment is 'proved' prior to verifying effective isolation
   c isolation device secured in OFF position
   d warning notices posted
   e all relevant safety and functional checks are completed prior to restoration of supply

3 state the basic principles of undertaking fault finding as
   a knowledge and understanding of relevant electrotechnical systems and equipment
   b optimum use of personal and others experience and expertise of systems and equipment
   c use of a logical approach

4 list and describe the stages of logical fault diagnosis and rectification
   a collection and collation of data
      i information on events leading up the fault
      ii information from verbal and written reports
      iii operating records, fault finding charts
   b analysis of evidence and use of standard tests to diagnose cause of faults
   c interpretation of test results
      i systematic procedure
      ii diagnosis of cause
   d functional checks and test to verify rectification and restoration as per appropriate regulations

5 list circumstances where faults may occur in an electrotechnical system
   a wiring
   b cable terminations
   c accessories/controls (eg switches, switchgear, contactors, electronics)
   d instrumentation/metering
   e protective devices
   f luminaries
   g flexible cable/cords
   h components

6 describe typical symptoms as
   a complete loss of supply at origin
   b localised loss of supply
   c overload or fault current devices operating
   d transient voltages
   e insulation failure
   f component failure

7 list common faults as
   a mechanical
      i structural failures
      ii connections
   b electrical
      i overload
      ii earth leakage
      iii open circuit, short circuit
      iv oversensitive/non performing protective devices

8 describe the factors which influence repair or replacement
   a costs
   b availability of replacement
   c downtime under fault condition
   d legal responsibility – warranties

9 state the factors which may effect rectification
   a access to system/equipment
   b provision of emergency/standby supply
   c client demand for continuous supply

10 recognise situations where special precautions should be applied
   a fibre optic cabling
   b antistatic precautions
   c damage to electronic devices by ‘over voltage’
   d avoidance of shut down for IT equipment
   e risk of high frequency or large capacitive circuits
   f presence of storage batteries

11 describe the requirements of testing with reference to
   a types of test equipment
   b sequence and procedures for tests
   c application of the current Wiring Regulations

12 describe procedures for dealing with
   a report forms and documentation
   b customer/client

Outcome 2 Select appropriate methods and use tools, equipment and instruments to restore systems equipment and components to working order

Practical Activities

The candidate will be able to

1 apply rectification techniques
2 determine appropriate procedures for re commissioning of electrical systems, components and equipment
3 demonstrate safe and efficient practices
4 restore system, equipment, component to working order

Underpinning knowledge

The candidate will be able to

1 list relevant sources of information to facilitate re commissioning
   a IEE Wiring Regulations
   b contract specifications
   c distribution/wiring diagrams
   d manufacturers instructions
   e relevant statutory legislation

2 describe the requirements of testing and commissioning with reference to
   a types of test equipment
   b sequence and procedures for tests
   c application of the current Wiring Regulations

3 describe procedures for dealing with
   a report forms and documentation
   b customer/client

4 select instruments suitable for testing and commissioning
   a voltage indicating device and proving unit
   b low-resistance ohmmeter /continuity tester
   c insulation resistance tester
   d earth electrode resistance tester
   e earth fault loop impedance and PSCC/PFC tester
   f RCD tester
   g tong testers/clamp meters

5 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

6 describe how to carry out functional checks and tests to verify rectification and restoration of system and equipment including as appropriate
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f operation of RCD

g functional testing

7 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

8 state the necessity for advising the customer/client of the need for additional restoration work to building fabric as required
a brickwork
b plastering
c decorating

9 list procedures for the disposal of waste materials and leaving site in a safe and clean condition

10 describe the process for completion after rectification in terms of
a responsibilities of relevant personnel
b documentation

Unit 6 - 306 Instrumentation Inspection, testing and commissioning

Rationale

This unit identifies the principles and processes applicable to the inspection, testing and commissioning for instrumentation and associated equipment. The content of this unit covers procedures for inspection, testing to meet the requirements of the devices and the industry codes of practice.

There are two outcomes to this unit. The candidate will be able to

1. use safe, effective and efficient working practices to complete instrumentation installation
2. select appropriate working methods and use tools, equipment and instruments for installation and commissioning

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by and EV.

Outcome 1 Use safe, effective and efficient working practices to complete instrument installations

Practical Activities

The candidate will be able to

1 determine all procedures and equipment to install and connect instrumentation
2 obtain the necessary clearances or approvals for the work to be undertaken
3 connect and complete an instrumentation installation
4 understand and complete as appropriate risk assessments and method statements

Underpinning knowledge

The candidate will be able to

1 describe the methods and procedures necessary to make an area safe before starting work by
   a using barriers and/or tapes
   b placing warning signs in appropriate positions
   c informing any persons who may be affected
   d isolating power and associated systems
   e obtaining official clearance (Permit to Work)
   f risk assessments and method statements

2 describe the general types of work that need to be included in installation/assembly activities
   a installing instrumentation/display devices and associated equipment and systems into new sites or locations
   b replacement of instrumentation/display devices and associated equipment

3 state the factors that need to be considered when planning an installation
   a site conditions and locations of components
      i structure – component parts, access,
      ii building fabric
      iii external influences
   b storage of instruments, equipment, parts and materials
   c tools and equipment
   d minimising disruption to adjacent work areas
   e how to estimate the length of time needed for the installation

4 identify the parties concerned with installations and their relationships
   a client
   b main-contractor
   c sub-contractor
   d suppliers
   e consultants

5 state the role of relevant parties with respect of regulatory requirements
   a Building regulations
   b environmental
   c health and safety
   d electrical regulations

6 read and interpret drawings and specifications to prepare requisitions
   a site plans
   b block diagrams
   c location diagrams
   d circuit diagrams

7 state procedures involved with producing a formal contract and the role of contracts in installation activities

8 state the use of the following to monitor contract progress and plan a test, inspection and commissioning programme
- a bar charts
- b critical path networks
- c site records
- d site diaries
- e variation orders

9 explain the importance of
- a coordinating installation/assembly contracts with other trades
- b recognising the implications of variations

10 explain the importance of effective communication to maintain good relationships with
- a customer/client
- b surveyor
- c main contractor
- d colleagues and other trades

11 state the suppliers' standard voltages for transmission and distribution

12 describe the single and three phase four wire systems of distribution and the importance of balancing

13 describe arrangements for electrotechnical systems in respect of
- a isolation and switching
- b overcurrent protection
- c earth fault protection

14 state the dangers associated with the use of electricity and describe methods of controlling risk with reference to
- a isolation and switchgear
- b direct and indirect contact
- c installation terminals
- d location of equipment and components

15 identify appropriate wiring systems and enclosures for instrumentation/display devices with reference to
- a use of the device
- b environmental conditions
- c current demand
- d overcurrent protection

16 describe the advantages and limitations of common wiring systems and enclosures used for instrumentation
- a wiring systems
  - i mims/micc
  - ii pvc/swa cable
  - iii pvc single core
  - iv thermoplastic (pvc) twin with cpc
  - v fire retatdant cable
- b wiring enclosures
  - i pvc and steel conduit
  - ii pvc and steel trunking
  - iii cable tray and ladder
  - iv ducting systems

17 state the conditions for effective termination of wiring systems cables and conductors
- a electrically and mechanical sound
- b ability to carry design current
- c prevention of corrosion

18 state the factors affecting selection of conductor size as
- a design current
- b voltage drop
- c regulations concerning thermal constraints and shock protection

19 carry out calculations to
- a determine circuit current
- b determine protective device
- c apply correction factors and diversity
- d determine voltage drop
- e select appropriate conductor

20 determine the size of conduit appropriate to the size and number of cables

21 explain the terms
- a earthing
- b bonding

22 describe the function and installation of protective equipment
- a overcurrent devices
- b fuses
- c circuit breakers
- d residual circuit breakers

23 identify non-electrical systems and controls related to instrumentation/display devices
- a pipework systems for fluids and gases
  - i colour codes
  - ii insulation/protection
- b pipework components
  - i valves
  - ii filters
  - iii couplings
- c controls
  - i flow
  - ii pressure
  - iii density
  - iv temperature

24 explain the importance of careful handling of electronic components

25 describe the application of the following in relation to instrumentation/display devices
   a switches
   b solenoids
   c transducers, sensors
   d motors
   e PLCs

Outcome 2 Select appropriate methods and use tools, equipment and instruments for inspection, testing and commissioning

Practical Activities

The candidate will be able to

1 determine appropriate procedures for inspection and testing of instrumentation/display devices and the related systems, components and equipment
2 demonstrate safe and efficient practices for inspection
3 select and use instruments for testing and commissioning purposes.

Underpinning knowledge

The candidate will be able to

1 state the purpose of inspection and commissioning and the factors to considered
   a process as part of the initial verification procedure for instrumentation/display devices forming part of a new installation
      i complies with Regulations
      ii meets specification
      iii safe to use
   b factors to be considered
      i safety precautions - assessment of safe working practices, permit to work, isolation
      ii purpose and usage of systems and equipment – identification of circuits, equipment
      iii test procedures – test instruments, correct methods
      iv sources of information – relevant data, accurate labelling, recording
      v contact with relevant parties – customers/clients

2 identify the purpose and conditions for periodic inspection
   a part of a planned schedule of review
   b alterations/additions to electrical systems
   c external influences

3 list relevant sources of information to facilitate inspection and testing
   a IEE Wiring Regulations
   b contract specifications
   c distribution/wiring diagrams
   d manufacturers instructions
   e relevant statutory legislation

4 list the items associated with visual inspection prior to commissioning
   a circuit connections
   b conduit, trunking, traywork
   c components
   d related systems

5 select instruments suitable for testing and commissioning
   a multimeters
   b wattmeters
   c signal/pulse generators
   d oscilloscope
   e current tracer
   f logic probe

6 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

7 describe how to carry out tests for
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f operation of RCD
   g functional testing

8 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

9 describe the certification process for a completed installation
   a responsibilities of relevant personnel
   b documentation
      i Electrical Installation Certificate
      ii Schedule of Inspections
      iii Schedule of Test Results

10 identify procedures to be followed before signing inspection and completion certificates including
   a ensuring that installed device complies with the specification and relevant standards
   b action to be taken to rectify any faults or omissions.

Unit 7 – 307 Instrumentation Fault diagnosis and rectification

Rationale

This unit identifies the principles and processes applicable to fault diagnosis on instrumentation and display devices and associated electrical systems. The content of this unit covers safe and approved procedures for fault finding and the re-establishment to operational conditions.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to undertake fault diagnosis
2 carry out commissioning to restore systems, components and equipment to working order

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Use safe effective and efficient working practices to undertake fault diagnosis

Practical Activities

The candidate will be able to

1 determine faults in instrumentation/display devices and associated equipment
2 apply rectification techniques
3 restore devices and equipment to working order
4 understand and complete as appropriate risk assessments and method statements

Underpinning knowledge

The candidate will be able to

1 identify typical systems and monitoring equipment utilising instrumentation/display devices
   a systems
      i ELV and LV single and multiphase circuits
      ii piped services (fluid, gases)
      iii mechanical and electrical plant and handling systems
      iv control systems
   b monitoring equipment
      i pressure
      ii levels
      iii temperature
      iv speed, frequency
      v flow rate
      vi density
      vii electrical measures
      viii control systems and components

2 state the safe working procedures to be applied before undertaking fault diagnosis
   a on load, off load isolating devices are identified and operated
   b voltage indication equipment is 'proved' prior to verifying effective isolation
   c isolation device secured in OFF position
   d warning notices posted
   e relevant system/process isolation
   f special precautions applied to hazardous systems
   g all relevant safety and functional checks are completed prior to restoration of supply
   h risk assessments and method statements

3 state the basic principles of undertaking fault finding as
   a knowledge and understanding of relevant instrumentation/display devices and related system and equipment
   b optimum use of personal and others experience and expertise of systems and equipment
   c use of a logical approach

4 list and describe the stages of logical fault diagnosis and rectification
- a collection and collation of data
  - i information on events leading up the fault
  - ii information from verbal and written reports
  - iii operating records, fault finding charts
- b analysis of evidence and use of standard tests to diagnose cause of faults
- c interpretation of test results
  - i systematic procedure
  - ii diagnosis of cause
- d functional checks and test to verify rectification and restoration as per appropriate regulations

5 list circumstances where faults may occur in an instrumentation/display device system
- a wiring
- b cable terminations
- c accessories/controls (eg switches, switchgear, contactors, electronics)
- e protective devices
- f flexible cable/cords
- g related components

6 describe typical symptoms as
- a loss of electrical supply at origin
- b overload or fault current devices operating
- c insulation failure
- d related plant/system failure

7 list common faults as
- a mechanical
  - i structural failures
  - ii connections
- b electrical
  - i overload
  - ii earth leakage
  - iii open circuit, short circuit
  - iv oversensitive/non performing protective devices

8 describe the factors which influence repair or replacement
- a costs
- b availability of replacement
- c downtime under fault condition
- d legal responsibility – warranties

9 state the factors which may effect rectification
- a access to system/equipment
- b provision of emergency/standby supply
- c client demand for continuous operation

10 recognise situations where special precautions should be applied
- a fibre optic cabling
- b antistatic precautions
- c damage to electronic devices by ‘over voltage’
- d avoidance of shut down for IT equipment
- e risk of high frequency or large capacitive circuits
- f presence of hazardous environmental conditions

11 describe the requirements of testing with reference to
- a types of test equipment
- b sequence and procedures for tests
- c application of the current Wiring Regulations

12 describe procedures for dealing with
   a report forms and documentation
   b customer/client

Outcome 2 Select appropriate methods and use tools, equipment and instruments to restore instrumentation/display devices and systems

Practical Activities

The candidate will be able to
1 apply rectification techniques
2 determine appropriate procedures for re commissioning of electrical systems, components and equipment
3 demonstrate safe and efficient practices
4 restore system, equipment, component to working order

Underpinning knowledge

The candidate will be able to

1 list relevant sources of information to facilitate re commissioning
   a IEE Wiring Regulations
   b contract specifications
   c distribution/wiring diagrams
   d manufacturers instructions
   e relevant statutory legislation

2 describe the requirements of testing and commissioning with reference to
   a types of test equipment
   b sequence and procedures for tests
   c application of the current Wiring Regulations

3 describe procedures for dealing with
   a report forms and documentation
   b customer/client

4 select instruments suitable for testing and commissioning
   a multimeters
   b wattmeters
   c insulation testers
   d logic probe, pulsar
   e stroboscope
   f signal generator
   g oscilloscope

5 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

6 describe how to carry out functional checks and tests to verify rectification and restoration of system and equipment including as appropriate
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f operation of RCD
   g functional testing

7 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

8 state the necessity for advising the customer/client of the need for any additional work to system as required
   a pipework, plant
   b insulation/protection

9 list procedures for the disposal of waste materials and leaving site in a safe and clean condition

10 describe the process for completion after rectification in terms of
   a responsibilities of relevant personnel
   b documentation

Unit 8 – 308 Highway electrical systems inspection, testing and commissioning

Rationale

This unit identifies the principles and processes applicable to the inspection, testing and commissioning of highway electrical equipment and systems. The content of this unit covers procedures for inspection, testing to meet the requirements of the installation and the industry codes of practice.

There are three outcomes to this unit. The candidate will be able to

1 recognise the function and application of highway electrical equipment and systems.
2 use safe, effective and efficient working practices to complete highway electrical installations
3 select appropriate working methods and use tools, equipment and instruments for inspecting, testing and commissioning highway electrical installations.

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by and EV.

Outcome 1 Use safe, effective and efficient practices to complete highway electrical installations

Practical Activities

The candidate will be able to
1. determine all procedures and equipment to install and connect a highway electrical installation
2. obtain the necessary clearances or approvals for the work to be undertaken
3. connect and complete a highway electrical installation

Underpinning knowledge

The candidate will be able to

1 Identify the limitations that act upon a highway electrical system as including:
   a light pollution,
   b glare (discomfort or disability)

2 Explain that different types of situations (motorways, subsidiary roads, tunnels and underpasses etc will require:
   a different design levels of illuminace/luminance
   b a variety of luminaire types to be considered
   c differing lamp types/colours to be used
   d different types of sign/signal equipment
   e protection against vandalism or mechanical damage

3. describe the methods and procedures necessary to make an area safe before starting work by
   a using barriers and/or tapes
   b placing warning signs in appropriate positions including lighting, signing and guarding on public highways and other routes to protect the public, livestock and vehicular traffic
   c informing any persons who may be affected
   d isolating power
   e obtaining official clearance (Permit to Work)

4. describe the general types of work that need to be included in installation activities
   a installing highway electrical equipment and systems into new sites or locations
   b replacement of highway electrical equipment and systems or extending facilities

5. state the factors that need to be considered when planning an installation
   a site conditions and locations of components
      i boundaries, access,
      ii installation, ground, fabric
      iii external influences
   b storage of components and materials
   c tools and equipment
   d minimising disruption to adjacent areas where public have access
   e how to estimate the length of time needed for the installation

6 identify the parties concerned with lighting installations and their relationships
   a client
   b main-contractor
   c sub-contractor
   d suppliers
   e consultants
   f Local Authorities
   g Highways Agency

7 read and interpret drawings and specifications to include
   a site plans
   b block diagrams
   c location diagrams
   d circuit diagrams
   e site diaries

8 explain the importance of coordinating highway electrical installation contracts with other trades

9 explain the importance of effective communication to maintain good relationships with
   a customer/client
   b supervisor
   c local authorities representatives (where applicable)
   d colleagues and other trades

10 state the Electricity Company's standard voltages for transmission and distribution
11 describe the single and three phase four wire systems of distribution and the importance of load balancing
12 describe arrangements for highway electrical systems in respect of
   a isolation and switching
   b overcurrent protection
   c earth fault protection

13 state the dangers associated with the use of electricity and describe methods of controlling risk with reference to
   a isolation and switchgear
   b direct and indirect contact
   c installation terminals
   d location of equipment and components

14 identify appropriate wiring systems and enclosures for lighting installations with reference to
   a use of the system
   b environmental conditions
   c current demand
   d overcurrent protection

15 describe the advantages and limitations of common wiring systems and equipment
   a wiring systems
      i mims/micc
      ii pvc/swa cable
      iii pvc single core
      iv thermoplastic (pvc) twin with cpc
      v fire retardant cable
   b equipment
      i street furniture, columns, sign and signal posts
      ii control equipment , feeder pillars and traffic signal control cabinets
      iii lamps
      iv accessories
      v trunking/ducting systems

16 state the conditions for effective termination of wiring systems cables and conductors
- a electrically and mechanically sound
- b ability to carry design current
- c prevention of corrosion

17 state the factors affecting selection of conductor size as
- a design current
- b voltage drop
- c regulations concerning shock protection

18 carry out calculations to
- a determine circuit current
- b determine protective device type and size
- c apply correction factors and diversity
- d determine voltage drop
- e select appropriate conductor

19 explain the terms
- a earthing
- b bonding

20 describe the function and installation of protective equipment
- a overcurrent devices
- b fuses
- c circuit breakers
- d residual circuit breakers

21 state that all associated equipment must be contained within enclosures that meet environmental/external influences as set out in the IP. code (B.S.E.N. 60529)

22 describe the various application of the IP. code (B.S.E.N. 60529 1992) to enclosures that form part of a Highway Electrical System, to include IP.2X, IP.4X, IP.X2, IP.X3, IP.X4, IP.X6

23 explain how different locations and types of Highway Electrical Systems will dictate/require the use of a particular wiring system or systems

24 identify from the Electrical Safety Quality and Continuity Regulations, the approved methods of in filling trenches and marking the routes of buried cables

25. state that all fixings of luminaires (lanterns) to lighting/signs/traffic signal posts/ columns or other types of installation must comply with manufacturer's instructions

26. list the industry approved methods of fixing luminaires, trunking, cabling and associated equipment to building fabrics or concrete walls, roofs, ceilings etc.

27. describe in detail the procedure for isolating equipment from an energy source

28 understand the need to avoid 'Live Working'

29 describe how the current wiring regulation requirements may impact upon the installation of a Highway Electrical system relative to:
- a location
- b environmental conditions
- c access and maintainability
- d cable routing and entry to enclosures

Outcome 2 Select appropriate methods and use tools, equipment and instruments for inspection, testing and commissioning

Practical Activities

The candidate will be able to

1 determine appropriate procedures for inspection and testing of lighting installations and the related systems, components and equipment
2 demonstrate safe and efficient practices for inspection
3 select and use instruments for testing and commissioning purposes.

Underpinning knowledge

The candidate will be able to

1 state the purpose of inspection and commissioning and the factors to considered
  a process as part of the initial verification procedure for a new installation
    i complies with Regulations
    ii meets specification
    iii safe to use
  b factors to be considered
    i safety precautions - assessment of safe working practices, permit to work , isolation
    ii purpose and usage of systems and equipment – identification of circuits, equipment
    iii test procedures – test instruments, correct methods
    iv sources of information – relevant data, accurate labelling, recording
    v contact with relevant parties – customers/clients,

2 identify the purpose and conditions for periodic inspection
  a alterations/additions to lighting systems
  b damage to lighting systems

3 list relevant sources of information to facilitate inspection and testing
  a IEE Wiring Regulations
  b contract specifications
  c distribution/wiring diagrams
  d manufacturers instructions
  e relevant statutory legislation
  f ILE Code of Practice for Public Lighting

4 list the items associated with visual inspection prior to commissioning
  a intake connections
  b circuits
  c cable routes
  e components

5 select instruments suitable for testing and commissioning
  a multimeters
  b wattmeters
  c clamp meters (tong testers)
  d transistor testers
  e signal generators
  f thermal imagers
  g cable locators
  h voltage indicating device and proving unit
  e low-resistance ohmmeter /continuity tester

j insulation resistance tester
k earth electrode resistance tester
l earth fault loop impedance and PSCC/PFC tester

6 explain the importance of
a verifying test instruments
b regular calibration
c use of documentary evidence

7 describe how to carry out tests for
a continuity
b insulation resistance
c polarity
d earth fault loop impedance
e earth electrode resistance
f operation of RCD
g functional testing

8 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

9 describe the certification process for a completed installation
a responsibilities of relevant personnel
b documentation
i Electrical Installation Certificate
ii Schedule of Inspections
iii Schedule of Test Results

10 identify procedures to be followed before signing inspection and completion certificates including
a ensuring that installed system complies with the specification and relevant standards
b action to be taken to rectify any faults or omissions
c handover arrangements

Unit 9 – 309 Highway Electrical Systems Fault diagnosis and rectification

Rationale

This unit identifies the principles and processes applicable to fault diagnosis on Highway Electrical Systems, equipment and components. The content of this unit covers safe and approved procedures for fault finding and the re-establishment of operational conditions.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to undertake fault diagnosis
2 carry out commissioning to restore systems, components and equipment to working order

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by and EV.

Outcome 1 Select and apply fault diagnosis and rectification techniques

Practical Activities

The candidate will be able to

1. utilise safe methods for undertaking fault diagnosis
2. determine faults in highway electrical systems and equipment
3. rectify faults in highway electrical systems

Underpinning knowledge

The candidate will be able to

1 identify highway electrical systems and equipment

2 state the safe working procedures to be applied before undertaking fault diagnosis
- a on load, off load isolating devices are identified and operated
- b voltage indication equipment is 'proved' prior to verifying effective isolation
- c isolation device secured in OFF position
- d warning notices posted
- e relevant safety and functional checks are completed prior to restoration of supply

3 state the basic principles of undertaking fault finding as
- a knowledge and understanding of relevant highway electrical systems and equipment
- b optimum use of personal and others experience and expertise of systems and equipment
- c use of manufacturers' data and information
- d use of a logical approach

4 list and describe the stages of logical fault diagnosis and rectification
- a collection and collation of data
  - i information on events leading up to the fault occurrence
  - ii information from verbal and written reports
- b analysis of evidence and use of standard tests to diagnose cause of faults
- c interpretation of test results
- d functional checks and test to verify rectification and restoration as per appropriate regulations

5 list circumstances where faults may occur in a highway electrical system
- a wiring
- b cable terminations
- c accessories/controls (eg switches, switchgear, contactors, electronics)
- d instrumentation/metering
- e protective devices
- f luminaries
- g flexible cable/cords
- h components

6 describe typical symptoms as
- a complete loss of supply
- b localised loss of supply
- c overload or fault current devices operating
- d transient voltages
- e insulation failure
- f component failure

7 describe the factors which influence repair or replacement
   a costs
   b availability of replacement
   c downtime under fault condition
   d legal responsibility – warranties

8 state the factors which may effect rectification
   a access to system/equipment
   b provision of emergency/standby supply
   c client demand for continuous supply

9 recognise situations where special precautions should be applied
   a damage to electronic devices by ‘over voltage’
   b risk of high frequency or large capacitive circuits

Outcome 2 Select appropriate methods and use tools, equipment and instruments to restore systems equipment and components to working order

Practical Activities

The candidate will be able to

1 apply rectification techniques
2 determine appropriate procedures for re commissioning of lighting systems, components and equipment
3 demonstrate safe and efficient practices
4 restore system, equipment, component to working order

Underpinning knowledge

The candidate will be able to

1 list relevant sources of information to facilitate re commissioning
   a IEE Wiring Regulations
   b contract specifications
   c distribution/wiring diagrams
   d manufacturers instructions
   e relevant statutory legislation

2 describe the requirements of testing and commissioning with reference to
   a types of test equipment
   b sequence and procedures for tests
   c application of the current Wiring Regulations

3 describe procedures for dealing with
   a report forms and documentation
   b customer/client

4 select instruments suitable for testing and commissioning
   a multimeters
   b wattmeters
   c voltage indicating device and proving unit
   d low-resistance ohmmeter /continuity tester
   e insulation resistance tester
   f earth electrode resistance tester
   g earth fault loop impedance and PSCC/PFC tester
   h clamp meters (tong testers)

5 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

6 describe how to carry out functional checks and tests to verify rectification and restoration of system and equipment including as appropriate
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f operation of RCD

g functional testing

7 explain the need to comply with test values and state the actions to take in the event of unsatisfactory results

8 list procedures for the disposal of waste materials and leaving site in a safe and clean condition

9 describe the process for completion after rectification in terms of
a responsibilities of relevant personnel
b documentation

Unit 10 - 310 Panel Building Inspection, testing and commissioning

Rationale

This unit identifies the principles and processes applicable to the inspection, testing and commissioning for electrical panels and associated equipment. The content of this unit covers procedures for inspection, testing to meet the requirements of the devices and the industry codes of practice.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to complete panel building and installation
2 select appropriate working methods and use tools, equipment and instruments for installation and commissioning

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Use safe, effective and efficient working practices to complete instrument installations

Practical Activities

The candidate will be able to

1 determine all procedures and equipment to install and connect instrumentation
2 obtain the necessary clearances or approvals for the work to be undertaken
3 connect and complete an instrumentation installation

Underpinning knowledge

The candidate will be able to

1 describe the methods and procedures necessary to make an area safe before starting work by
   a using barriers and/or tapes
   b placing warning signs in appropriate positions
   c informing any persons who may be affected
   d isolating power and associated systems
   e obtaining official clearance (Permit to Work)
   f utilising personal protective equipment

2 describe the general types of work that need to be included in panel building installation/assembly activities
   a installing panels and associated equipment and systems into new sites or locations
   b replacement of panels and associated equipment

3 state the factors that need to be considered when planning assembly/installation
   a site conditions and locations of components
      i structure – component parts, access,
      ii building fabric
      iii external influences
   b storage of parts and materials
   c tools and equipment
   d minimising disruption to adjacent work areas
   e how to estimate the length of time needed for the assembly/installation

4 identify the parties concerned with installations and their relationships
   a client
   b main-contractor
   c sub-contractor
   d suppliers
   e consultants
   f design engineer

5 state the role of relevant parties with respect of regulatory requirements
   a Building regulations
   b environmental
   c health and safety
   d electrical regulations
   e codes of practice
   f international standards

6 read and interpret drawings and specifications to prepare requisitions
   a site plans
   b block diagrams
   c location diagrams
   d circuit diagrams
   e client/design specifications
   f component specifications (manufactures) – instruments; equipment; accesssories

7 state procedures involved with producing a formal contract and the role of contracts in installation activities

8 state the use of the following to monitor contract progress
   a bar charts
   b critical path networks
   c site records
   d site diaries
   e variation orders

9 explain the importance of
   a coordinating installation/assembly contracts with other trades
   b recognising the implications of variations

10 explain the importance of effective communication to maintain good relationships with
   a customer/client
   b surveyor
   c main contractor
   d colleagues and other trades
   e panel component manufacturers/suppliers

11 describe arrangements for electrotechnical systems in respect of
   a isolation and switching
   b overcurrent protection
   c earth fault protection

12 describe methods of controlling risk with reference to
   a safe and secure isolation
   b control and switching
   c overcurrent and short-circuit protection
   d earth fault protection

13 identify appropriate wiring systems and enclosures for panels with reference to
   a function/application of the panel
   b environmental conditions
   c load rating – voltage; current; kVA; kW; power factor
   d protection – short-circuit; overcurrent
   e instruments

14 describe the advantages and limitations of wiring systems and techniques used for panels

15 state the conditions for effective termination of wiring systems cables and conductors
   a electrically and mechanically sound
   b ability to carry design current
   c prevention of corrosion
   d fit for purpose

16 state the factors affecting selection of conductor size as
   a design current
   b voltage drop
   c regulations concerning thermal constraints and shock protection

17 carry out calculations to
   a determine circuit current
   b determine protective device
   c apply correction factors and diversity
   d determine voltage drop
   e select appropriate conductor
   f load ratings – kVA; kW; power factor

18 explain the purpose of
   a earthing
   b equipotential bonding

19 describe the function and installation of protective equipment
   a overcurrent devices
   b fuses – re-wirable; cartridge; H.R.C.
   c circuit breakers
   d residual circuit breakers

20 describe types of panels, equipment and accessories, their applications and limitations
   a panels
      i switchgear
      ii mccs
      iii system control panels (Environmental Control; Process Control, e.g. flow; level; pressure)
   b equipment/accessories
      i switch-fuses
      ii distribution boards
      iii contactors and relays
      iv circuit breakers
      v instrumentation
      vi PLCs
      vii PCBs
      viii Sensors

Outcome 2 Select appropriate methods and use tools, equipment and instruments for inspection, testing and commissioning

Practical Activities

The candidate will be able to

1 determine appropriate procedures for inspection and testing of panels and the related systems, components and equipment
2 demonstrate safe and efficient practices for inspection
3 select and use instruments for testing and commissioning purposes.

Underpinning knowledge

The candidate will be able to

1 state the purpose of inspection, testing and commissioning and the factors to consider
  a initial verification procedure for an assembled/installed panel
    i complies with relevant Regulations and Standards as appropriate
      - Electricity at Work Regulations (1989)
      - I.E.E. Wiring Regulations (BS 7671)
      - BS EN 60204 (Safety of Machinery, Electrical Equipment of Machines)
      BS EN 60439 (Specification for Low-voltage Switch-gear and Control-gear Assemblies)
    ii client and design specifications
    iii fit for purpose
    iv safe to use

b factors to be considered
    i safety – isolation methods/equipment; mechanically sound structure; structure suitable for environment;
    ii systems and equipment – identification of circuits, equipment and components; position of instruments, equipment and components are in accordance with specifications/layout drawings
    iii sources of information are available
      - Relevant Regulations and Codes of practice
      - Client and design specifications, including any variations to the original
      - Circuit diagrams
      - Manufacturer's specifications
      - Records of previous inspection/test activities
    iv contact with relevant parties – client; design engineer; panel assembly team

2 list the items associated with visual inspection prior to testing/commissioning
  a cable/conductor terminations/connections - mechanically sound; identification
  b cable carriers conduit, trunking, traywork – capacity; fit for purpose; mechanically sound
  c cable/conductor supports – fit for purpose; mechanically sound
  d fitted equipment and components – mechanically secure; position
  e earthing arrangements – mechanically and electrically sound
  f circuit segregation (if appropriate)

3 select instruments suitable for testing, commissioning, stating applications and limitations
  a multimeters
  b wattmeters
  c logic probe
  d insulation resistance tester
  e oscilloscope

f low-resistance ohmmeter /continuity tester
g clamp meter (tong-tester)
h voltage indicating device and proving unit

4 explain the importance of
a verifying test instruments
b regular calibration
c documentary evidence

5 describe how to carry out tests for
a continuity
b insulation resistance
c polarity/phase sequence
d earth fault loop impedance
e earth electrode/connections/terminal resistance
f operation of RCD
g functional testing

8 explain the need to comply with expected/recommended test values and state the actions to take in the event of unsatisfactory results

9 describe the certification process for a completed assembly/installation of a panel
a responsibilities of relevant personnel
b documentation
i Completion Certificate
ii Schedule of Inspections
iii Schedule of Test Results
iv Client Handover

10 identify procedures to be followed before signing inspection and completion certificates including
a ensuring that the assembled/installed panel complies with the specification and relevant standards
b action to be taken to rectify any faults or omissions

Unit 11 – 311 Panel building Fault diagnosis and rectification

Rationale

This unit identifies the principles and processes applicable to fault diagnosis on panels and associated electrical systems. The content of this unit covers safe and approved procedures for fault finding and the re-establishment to operational conditions.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to undertake fault diagnosis
2 carry out commissioning to restore systems, components and equipment to working order

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Use safe effective and efficient working practices to undertake fault diagnosis

Practical Activities

The candidate will be able to

1 determine faults in panels and associated equipment
2 apply rectification techniques
3 restore devices and equipment to working order

Underpinning knowledge

The candidate will be able to

1 identify typical systems related to panels
   a ELV and LV single and multiphase systems – heating; lighting; power; control; security
   b non-insulated conductor systems (eg Bus Bars)

2 state the safe working procedures to be applied before undertaking fault diagnosis
   a on load, off load isolating devices are identified and operated in accordance with industry approved procedures
   b voltage indication equipment is 'proved' prior to verifying effective isolation
   c isolation device secured in OFF position
   d warning notices posted
   e relevant system/process isolation
   f special precautions applied to hazardous systems
   g all relevant safety and functional checks are completed prior to restoration of supply

3 understand the fundamental principles of undertaking fault finding as
   a knowledge of systems, equipment, components and instruments fitted in panels in terms of
      i applications
      ii limitations
      iii operation
   b optimum use of personal and others experience and expertise
   c use of a logical approach

4 list and describe the stages of logical fault diagnosis and rectification
   a collection and collation of data
      i information on events leading up the fault
      ii information from verbal and written reports
      iii operating records, fault finding charts
   b analysis of evidence and use of standard tests to diagnose cause of faults
   c interpretation of test results
      i systematic procedure
      ii diagnosis of cause
   d functional checks and tests to verify rectification and restoration as per relevant regulations, codes of practice and industry standards

5 list assembly characteristics of a panel where faults may occur
   a wiring –cables, cords, conductors
   b cable/conductor terminations/connections
   c accessories/controls (eg switches, switchgear, contactors, relays, instruments, electronics)
   d protective devices
e `related components of panel

6 describe typical symptoms as
   a loss of electrical supply at origin
   b overload or fault current devices operating
   c instrument readings
   d related plant/system failure
   e out of sequence operation
   f low or high outputs – voltage; current; signal

7 list common faults as
   a mechanical
      i structural failures
      ii connections
      iii relay/contactor mechanism
   b electrical
      i overload
      ii earth leakage
      iii open circuit, short circuit – cables; conductors; coils (contactors; relays; transformers)
      iv oversensitive/non performing protective devices

8 describe the factors which influence repair or replacement
   a costs – loss of production; labour; replacement components
   b availability of replacement components
   c contract obligations/legal responsibility – warranties

9 recognise situations where special precautions should be applied during fault-finding activities
   a fibre optic cabling
   b antistatic precautions
   c damage to electronic devices by 'over voltage'
   d avoidance of shut down for IT equipment
   e risk of high frequency or large capacitive circuits
   f presence of hazardous environmental conditions

10 describe the requirements of fault diagnosis in terms of
   a The Electricity at Work regulations
   b I.E.E. Wiring Regulations
   c BS EN 60204 (Safety of Machinery, Electrical Equipment of Machines)
   d BS EN 60439 (Specification for Low-voltage Switch-gear and Control-gear Assemblies)

Outcome 2 Select appropriate methods and use tools, equipment and instruments for diagnosing and rectifying faults on panels

Practical Activities

The candidate will be able to

1 apply rectification techniques
2 determine appropriate procedures for re commissioning of electrical systems, components and equipment
3 demonstrate safe and efficient practices
4 restore system, equipment, component to working order

Underpinning knowledge

The candidate will be able to

1 list relevant sources of information to facilitate re commissioning
   a relevant regulations and codes of practice
   b contract specifications
   c wiring diagrams
   d connection diagrams
   e manufacturers specifications

2 describe the requirements of testing and commissioning with reference to
   a The Electricity at Work regulations 1989
   b I.E.E. Wiring Regulations (BS 7671)
   c BS EN 60204 (Safety of Machinery, Electrical Equipment of Machines)
   d BS EN 60439 (Specification for Low-voltage Switch-gear and Control-gear Assemblies)

3 describe procedures for dealing with
   a report forms and documentation
   b Client/design engineer

4 select instruments suitable for fault diagnosis and rectification stating applications and limitations
   a multimeters
   b wattmeters
   c logic probe
   d insulation resistance tester
   e oscilloscope
   f low-resistance ohmmeter /continuity tester
   g clamp meter (tong-tester)
   h voltage indicating device and proving unit

5 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence and records

6 describe how to carry out checks and tests to verify rectification and restoration of panel to working order in accordance with relevant specifications
   a continuity
   b insulation resistance
   c polarity
   d earth fault loop impedance
   e earth electrode resistance
   f operation of protective devices
   g load testing of panel for operation and integrity

7 explain the need to comply with expected/recommended test values and state the actions to take in the event of unsatisfactory results

8 state the necessity for advising the customer/client of the need for any additional work to panel as required

9 list procedures for the disposal of waste materials and leaving site in a safe and clean condition

10 describe the process for completion after rectification in terms of
   a responsibilities of relevant personnel
   b documentation
   c handover

Unit 12 - 312 Electrical machines Inspection, testing and commissioning

Rationale

This unit identifies the principles and processes applicable to the inspection, testing and commissioning of electrical machines. The content of this unit covers procedures for inspection, testing to meet the requirements of the installation and the industry codes of practice.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to complete electrical installations
2 select appropriate working methods and use tools, equipment and instruments for installation and commissioning

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by an EV.

Outcome 1 Use safe, effective and efficient working practices to complete repairs to electrical machines

Practical Activities

The candidate will be able to

1 determine all procedures to be followed and equipment needed to inspect and test electrical machines
2 obtain the necessary clearances or approvals for the work to be undertaken
3 complete an electrical machine repair inspection and test

Underpinning knowledge

The candidate will be able to

1 describe the requirements of inspection and testing with reference to
   a types of instruments equipment
   b sequence and procedures for inspection and testing
   c relevant statutory legislation
   d relevant codes of practice and industry standards

2 interpret drawings and specifications
   a winding layout drawings
   b winding connection diagrams
   c machine specifications
   d machine rating plates
   e component specifications
   f repair sheets
   g job sheets

3 describe methods of on- and off-load testing for
   a three-phase a.c. motors – cage rotor; wound rotor
   b single-phase motors
   c d.c. motors/generators – series; shunt; compound; separately- excited

4 state the advantages and limitations of on- and off-load testing for
   a three-phase a.c. motors – cage rotor; wound rotor
   b single-phase motors
   c d.c. motors/generators – series; shunt; compound; separately- excited

5 describe the procedures and techniques for testing transformers
   a short-circuit
   b open-circuit

6 state the advantages and limitations of testing methods for transformers
   a short-circuit
   b open-circuit

7 describe industry approved procedures for
   a flash testing
   b locked rotor testing

Outcome 2 select appropriate working methods and use tools, equipment and instruments for the inspection and testing of electrical machines

Practical Activities

The candidate will be able to

1 determine appropriate procedures for inspection and testing of electrical machines and the related systems, components and equipment
2 demonstrate safe and efficient practices for inspection
3 select and use instruments for testing and commissioning purposes.

Underpinning knowledge

The candidate will be able to

1 state the purpose of visual inspection in terms of component parts
   a individually
   b part of an assembled machine
   c secure location
   d mechanically sound
   e fit for purpose

2 list relevant sources of information to facilitate inspection and testing
   a machine specifications
   b winding layout/connection diagrams
   c manufacturers' specifications
   d repair sheet instructions/specification
   e relevant statutory legislation
   f industry codes of practice

3 select instruments suitable for inspection and testing
   a multimeters
   b clamp meters (tong testers)
   c wattmeters
   d insulation resistance tester
   e speed sensors
   f signal generator
   g oscilloscope
   h voltage with stand testers
   i growlers
   j flux testers

4 explain the importance of
   a verifying test instruments
   b regular calibration
   c use of documentary evidence

5 describe how to carry out tests for
   a continuity
   b insulation resistance
   c polarity
   d phase sequence

6 describe how to carry-out
   a on and off load testing
   b open-circuit testing
   c short-circuit testing
   d voltage withstand testing

7 explain the need to comply with expected test results and state the actions to take in the event of unsatisfactory results

8 describe the certification process for a completed inspection and test
   a responsibilities of relevant personnel
   b documentation
   c action to be taken following an unsatisfactory test

Unit 13 – 313 Electrical machines repair and rewind

Rationale

This unit identifies the principles and processes applicable to repair and rewind of electrical machines. The content of this unit covers safe and approved procedures for overhaul, refurbishment, repair, rewind, component replacements and modifications and the re-establishment to operational condition.

There are two outcomes to this unit. The candidate will be able to

1 use safe, effective and efficient working practices to undertake repair and rewind
2 carry out commissioning to restore machines to working order

Assessment
This will be by a practical assignment which will cover the outcomes stated in the syllabus. This will include a short answer test of underpinning knowledge. City & Guilds will provide an assignment template and a bank of written questions. Centres will need to have their own assignments approved for use by and EV.

Outcome 1 use safe, effective and efficient working practices to undertake repair, rewind and overhaul

Practical Activities

The candidate will be able to

1 carry out servicing and rewind of electrical machines
2 apply repair and overhaul techniques and practices
3 restore machines and equipment to working order

Underpinning knowledge

The candidate will be able to

1 state the factors that need to be considered when planning the repair/rewind/overhaul of an electrical machine
   a sequence/procedure of dismantling – protection of component parts
   b identification for re-assembly of component parts
   c availability of components that need replacing
   d removal techniques of old/burn-out windings
   e state of bearings
   f cleaning procedures/materials and techniques
   g storage of parts and materials
   h tools and equipment
   i time needed for the repair/rewind/overhaul

2 identify the external influences which can affect the repair/rewind/overhaul of an electrical machine
   a client requirements, eg maintenance/servicing/repair contract
   b availability of material and replacement parts from suppliers
   c technical data, eg machine specifications; winding layout drawings

3 state the safe working procedures to be applied before undertaking the repair of an electrical machine 'In-situ'
   a on load, off load isolating devices are identified and operated
   b voltage indication equipment is 'proved' prior to verifying effective isolation
   c isolation device secured in OFF position
   d warning notices posted
   e relevant system/process isolation
   f special precautions applied to hazardous environments
   g all relevant safety and functional checks are completed prior to restoration of supply

4 list and describe the stages of logical servicing and repair techniques
   a collection and collation of data
      i information from verbal and written reports
      ii operating records, fault finding charts

   b analysis of evidence and use of standard servicing procedures and checks
   c interpretation of
      i systematic procedure
      ii diagnosis of cause
      iii relevant test results
      iv repair sheets
      v manufacturers' instructions/specifications
      vi customer specifications
   d checks and tests to verify repair and overhaul has been completed in accordance with appropriate regulations and specifications

5 state the advantages, disadvantages and limitations of repairing/rewinding an electrical machine in terms of
- a copy winding
- b rewind options
- c overhauling

6 list components where faults may occur in an electrical machine
- a internal wiring/connections
- b cable terminations
- c accessories/controls (eg switches, switchgear, contactors, control equipment)
- d protective devices
- e flexible cable/cords
- f winding layout/connections
- g incorrect insulation class

7 describe typical fault symptoms as
- a failure to start
- b overload or fault current devices operating
- c vibration/noisy operation
- d overheating
- e reduced/increased speed

8 describe the procedures/methods/sequences to identify fault location in terms of
- a failure to start
- b overload or fault current devices operating
- c vibration/noisy operation
- d overheating
- e reduced/increased speed

9 list common faults as
- a mechanical
  - i structural failures
  - ii connections
  - iii bearings
- b electrical
  - i overload
  - ii earth leakage
  - iii open circuit, short circuit
  - iv oversensitive/non performing protective devices
  - v insulation failure

10 select instruments suitable for locating faults
- a multimeters
- b wattmeters
- c speed sensors
- d low resistance ohmmeter/continuity tester
- e oscilloscope
- f insulation resistance tester

11 describe the factors which influence repair or replacement
- a costs
- b availability of replacement
- c downtime under fault condition
- d legal responsibility – warranties

Outcome 2 Carry out repair, rewind and overhaul to restore electrical machines to working order

Practical Activities

The candidate will be able to
1 apply repair, rewind and overhaul techniques
2 determine appropriate procedures for the repair, rewind and overhaul of electrical machines
3 demonstrate safe and efficient practices
4 restore machine to working order in accordance with relevant specification

Underpinning knowledge

The candidate will be able to

1 State the types of materials used for electrical machine rewind, their advantages, limitations and applications
   a varnish
   b winding-insulation
   c windings
   d sleeving
   e heat-resistant insulated conductors/cables

2 State the types and limitations of conductor/cable terminations and connections in electrical machines

3 describe the procedures and techniques for
   a removal of old/burnt-out windings
   b formatting winding assemblies
   c identifying and replacing faulty components such as,
      i brushes and brush-gear
      ii bearings
   d dismantling and assembling
   e overhauling

4 list relevant sources of information to facilitate repair, rewind and overhaul
   a repair sheet instructions/specifications
   b wiring diagrams
   c winding layout/connection drawings and diagrams
   d types of windings
   e manufacturers specifications/instructions
   f relevant statutory legislation
   g relevant codes of practice and industry standards
   h machine rating plates

5 describe procedures for dealing with
   a instruction/report forms and documentation
   b customer/client

6 state the necessity for advising the customer/client of the need for any additional work to the machine as required

7 list procedures for the disposal of waste materials and leaving the work site in a safe and clean condition

8 describe procedures for confirming the completion of the repair, rewind or overhaul

Further information

Further information regarding centre/scheme approval or any aspect of assessment of the award should be referred to the relevant City & Guilds regional/national office:

Region	Telephone	Facsimile
City & Guilds London and South East	020 7294 8139	020 7294 2419
City & Guilds Southern	020 7294 2677	020 7294 2412
City & Guilds South West	01823 722200	01823 444231
City & Guilds East Anglia	01480 308300	01480 308325
City & Guilds East Midlands	01773 842900	01773 833030
City & Guilds West Midlands	0121 503 8900	0121 359 7734
City & Guilds North East	0191 402 5100	0191 402 5101
City & Guilds North West	01925 897900	01925 897925
City & Guilds Yorkshire	0113 380 8500	0113 380 8525
City & Guilds Northern Ireland	028 9032 5689	028 9031 2917
City & Guilds Scotland	0131 226 1556	0131 226 1558
City & Guilds Wales	02920 748600	02920 748625

City & Guilds Head Office – Customer Relations	020 7294 2800	020 7294 2400

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