

# **Certificate in Electrical Power Engineering – Distribution & Transmission at SCQF Level 5 (2343-17)**

December 2015 Version 1.0

**Qualification Handbook**

## Qualification at a glance

<b>Subject area</b>	Electrical Power Engineering
<b>City &amp; Guilds number</b>	2343
<b>Age group approved</b>	16+
<b>Entry requirements</b>	None
<b>Assessment</b>	Multiple choice and short answer test
<b>Approvals</b>	
<b>Support materials</b>	Centre handbook Assessment pack
<b>Registration and certification</b>	Consult the Walled Garden/Online Catalogue for last dates

<b>Title and level</b>	<b>City &amp; Guilds number</b>	<b>Accreditation number</b>
Certificate in Electrical Power Engineering – Distribution & Transmission at SCQF Level 5	2343-17	R200 04

<b>Version and date</b>	<b>Change detail</b>	<b>Section</b>

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# 1 Introduction

This document tells you what you need to do to deliver the qualifications:

Area	Description
Who is the qualifications for?	This qualification is for those in the power industry. They could be undertaking a Modern Apprenticeship, wishing to gain knowledge and prove competence or progress to a more responsible role.
What do the qualifications cover?	These qualifications allow candidates to learn, develop and practise the skills required for employment and/or career progression in
What opportunities for progression are there?	They allow candidates to progress into employment or to the following City & Guilds qualifications: Diploma in Electrical Power Engineering – Distribution & Transmission at SCQF Level 6
Who did we develop the qualification with?	Power sector employers and the Sector Skills Council Energy & Utility Skills (EU Skills).
Is it part of an apprenticeship framework or initiative?	This qualification supports the Power Industry Distribution and Transmission apprenticeships at Level 5.

## Structure

To achieve the XXXXXXX learners must be achieve

## Certificate in Electrical Power Engineering – Distribution and Transmission at SCQF Level 5

UAN	City & Guilds unit number	Unit title	Group (if applicable)	Credit Value	GLH
<b>Mandatory</b>					
	501	Understand legislation in the power industry		6	
	502	Mathematics, mechanical and electrical theory in power engineering		12	
	503	Power engineering electrical networks, plant and apparatus		9	
	504	Power engineering: cables, sub stations and overhead lines		9	

## 2 Centre requirements

### Approval

To offer these qualifications, new centres will need to gain both centre and qualification approval. Please refer to the *City & Guilds Centre Manual* for further information.

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

### Resource requirements

#### **Centre staffing**

City & Guilds quality assurance includes initial centre approval, scheme approval, the centre's own procedures for monitoring quality and City & Guilds' ongoing monitoring by an External Verifier.

City & Guilds External Verifiers will:

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

In line with the Sector Skills Council Energy & Utility Skills' assessment strategy, all assessors, internal verifiers and external verifiers involved in the delivery of power sector qualifications (within which the renewables sector falls) must:

- demonstrate a high level of interpersonal and communication skills, comparable with at least the Key Skills and Core Skills (Communication) identified within 'Develop productive working relationships with colleagues' (MSC D1)
- have up-to-date knowledge of current practice and emerging issues within their industry and be aware there may be differences between the four UK countries
- have a thorough understanding of the assessment units for the qualifications they are assessing or verifying and be able to interpret them and offer advice on assessment-related matters
- show experience and working knowledge of the assessment and verification processes relating to the context in which they are working
- demonstrate they have relevant and credible technical and/or industrial experience not more than 5 years old - at a level relevant to their role and the award
- show they are able to act as an emissary of the awarding body and be able to facilitate consistency across centres
- have assessor or verifier units of competence (A or V units or D units)- or be working towards the appropriate TAQA (6317) - or TQFE or TQSE for assessment or verification in Scotland
- demonstrate a commitment to continuing professional development and to keeping abreast of the changing environment and practices in their industry
- demonstrate they have relevant and credible technical and/or industrial experience within the industry appropriate to these contexts – overhead, underground or substation.

Centre staff may undertake more than one role, eg tutor and assessor or internal verifier, but must never internally verify their own assessments.

### **Learner entry requirements**

City & Guilds does not set entry requirements for these qualifications. However, centres must ensure that candidates have the potential and opportunity to gain the qualification successfully.

### ***Age restrictions***

City & Guilds cannot accept any registrations for candidates under 16 as this qualification is not approved for under 16s.

## 3 Delivering the qualification

### Initial assessment and induction

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

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

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

### Support materials

The following resources are available for these qualifications:

Description	How to access
Assessment pack	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
Qualification handbook	<a href="http://www.cityandguilds.com">www.cityandguilds.com</a>

### Recording documents

Candidates and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, **Learning Assistant**, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at: [www.cityandguilds.com/eportfolios](http://www.cityandguilds.com/eportfolios).

City & Guilds has developed a set of *Recording forms* including examples of completed forms, for new and existing centres to use as appropriate. *Recording forms* are available on the City & Guilds website.

Although new centres are expected to use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by candidates and assessors at the centre. Amendable (MS Word) versions of the forms are available on the City & Guilds website.

## 4 Assessment

### Summary of assessment methods

For this qualification, learners will be required to complete the following assessments:

Assessment Types			
Unit	Title	Assessment method	Where to obtain assessment materials
501	Understand legislation in the power industry	Multiple choice paper 501  This is a paper-based multiple-choice paper that is internally marked and externally verified.	Assessment pack is downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
502	Mathematics, mechanical and electrical theory in power engineering	Multiple choice and short answer questions paper 502  This is a paper-based multiple-choice and short answer question paper that is internally marked and externally verified.	Assessment pack is downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
503	Power engineering electrical networks, plant and apparatus	Multiple choice paper 503  This is a paper-based multiple-choice paper that is internally marked and externally verified.	Assessment pack is downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
504	Power engineering: cables, sub stations and overhead lines	Multiple choice paper 504  This is a paper-based multiple-choice paper that is internally marked and externally verified.	Assessment pack is downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>

### Time constraints

The following must be applied to the assessment of this qualification:

- Candidates must finish their assessment within six months
- Assignments should take no longer than 8 hours. If they do, centres should consider why this is, and make sure that they are not trying to gather too much evidence.

### Assessment strategy

<insert content here>

***Test specifications***

The test specifications for the units within this qualification are provided in the Assessment pack which is freely downloadable from the City & Guilds website [www.cityandguilds.com](http://www.cityandguilds.com)

***Recognition of prior learning (RPL)***

Recognition of prior learning means using a person's previous experience or qualifications which have already been achieved to contribute to a new qualification.

## 5 Units

### Availability of units

All units follow.

## Unit 501

## Understand legislation in the power industry

<b>Level:</b>	5
<b>Credit value:</b>	6
<b>GLH:</b>	60
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by EUSkills
<b>Aim:</b>	<p>The learner will be able to demonstrate an understanding of the following when working in a power engineering environment:</p> <ul style="list-style-type: none"><li>• relative health, safety and environmental legislation, the use of method statements, codes of practice and risk assessments</li><li>• effective working management techniques to improve productivity of self and others</li><li>• methods of using and communicating technical information.</li></ul>

**Assessment type** Multiple choice test

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### Learning outcome:

The learner will:

1. demonstrate an understanding of relevant health and safety legislation

### Assessment criteria

The learner can:

- 1.1 describe the employers and employees responsibilities relating to the following health and safety regulations:
  - a. Health and Safety at Work Act 1974
  - b. Electricity at Work Regulations 1989
  - c. Management of Health & Safety at Work Regulations 2003
- 1.2 outline the statutory requirements relating to the following health and safety regulations:
  - a. Electricity Supply, Quality and Continuity Regulations 2002
  - b. Manual Handling Operations Regulations 1992
  - c. Provision and Use of Work Equipment Regulations 1998
  - d. Noise at Work Regulations 1989

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### Learning outcome

The learner will:

2. **Error! No text of specified style in document.**

### Assessment criteria

The learner can:

- 2.1 describe where to access sources of health and safety information and advice
- 2.2 state the roles and responsibilities safety officers/ representatives
- 2.3 state the roles, responsibilities and powers of Health and Safety Executive Inspectors
- 2.4 describe where you would find information relating to safety policies, codes of practice and procedures
- 2.5 outline the requirements of the Control of Substances Hazardous to Health Regulations 2002
- 2.6 identify relevant health and safety warning signs used in the power industry in relation to:
  - a. warning
  - b. prohibition
  - c. safe condition
  - d. mandatory safety signs.

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### Learning outcome

The learner will:

3. Understand the risk assessment process

### Assessment criteria

The learner can:

- 3.1 describe the reasons for reporting health and safety hazards
- 3.2 describe the reasons for carrying out risk assessments
- 3.3 define the terms 'hazard' and 'risk'
- 3.4 describe the principles of a risk assessment process to control hazards.

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### Learning outcome

The learner will:

4. Understand the importance of Personal Protective Equipment (PPE)

### Assessment criteria

The learner can:

- 4.1 describe why Personal Protective Equipment (PPE) should be stored, inspected and maintained correctly
- 4.2 outline the requirements relating to the Personal Protective Equipment at Work Regulations 1992.

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### **Learning outcome**

The learner will:

5. Understand the causes of accidents

### **Assessment criteria**

The learner can:

- 5.1 list the basic causes of accidents
  - 5.2 outline the requirements relating to Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995
  - 5.3 state the appropriate actions to be taken in the event of an injury / accident
  - 5.4 describe the effects of electric shock
  - 5.5 describe precautions which can be taken to prevent electric shock
  - 5.6 state the difference between direct and indirect electrical contact.
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### **Learning outcome**

The learner will:

6. Understand the storage and inspection of lifting equipment

### **Assessment criteria**

The learner can:

- 6.1 describe why lifting equipment should be stored, inspected and maintained correctly
  - 6.2 describe the meaning of these terms when using lifting equipment:
    - a. safe working load
    - b. maximum working load
  - 6.3 outline the requirements of the Lifting Operations and Lifting Equipment Regulations 1998.
- 

### **Learning outcome**

The learner will:

7. Understand about working at height

### **Assessment criteria**

The learner can:

- 7.1 describe the hazards associated with working at height
- 7.2 describe the preventative measures used to reduce the hazards of working at height (to stop or prevent cannot have both)
- 7.3 outline the requirements of the construction regulations with regard to work at height.

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### **Learning outcome**

The learner will:

8. Understand about working in confined spaces

### **Assessment criteria**

The learner can:

- 8.1 describe the hazards associated with working in confined spaces
  - 8.2 outline the requirements of the Confined Spaces Regulations 1997.
- 

### **Learning outcome**

The learner will:

9. Understand fire prevention

### **Assessment criteria**

The learner can:

- 9.1 describe the conditions required for the combustion and extinction of fire with respect to:
    - a. heat
    - b. oxygen
    - c. fuel
  - 9.2 describe methods of fire prevention
  - 9.3 outline methods for controlling and extinguishing fires using suitable fire fighting equipment for different types of fires
  - 9.4 describe the purpose and potential hazards of automatic fire fighting equipment
  - 9.5 outline the requirements of the Fire Safety Regulations 2005.
- 

### **Learning outcome**

The learner will:

10. Understand the importance of handling and disposing of waste

### **Assessment criteria**

The learner can:

- 10.1 describe the importance of safely storing, handling and disposing of waste products.

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## Learning outcome

The learner will:

11. Understand the importance of working effectively and efficiently

## Assessment criteria

The learner can:

- 11.1 identify methods to assess own levels of competence and learning needs
- 11.2 describe how to plan and implement a timetable for developing competence and improve their personal performance
- 11.3 describe the principles and importance of team working
- 11.4 state the importance of effective communication in a working environment
- 11.5 describe how to plan work activities effectively and efficiently
- 11.6 list types of information needed to plan tasks effectively
- 11.7 outline basic principles for dealing with problems in planned activities
- 11.8 describe basic methods to evaluate the success of a completed planned activity
- 11.9 outline the benefits of improving working practices and procedures
- 11.10 describe the importance of meeting customer expectations
- 11.11 describe the impact of interruptions and loss of supply to customers.

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## Learning outcome

The learner will:

12. Demonstrate an understanding of using and communicating technical information

## Assessment criteria

The learner can:

- 12.1 describe the types of written technical information used in a power engineering environment
- 12.2 describe the types of diagrammatic / pictorial technical information used in a power engineering environment
- 12.3 identify the types of technical information which can be gained from geographic diagrams / site plans
- 12.4 describe the purpose of the given safety documents used in the power sector:
- 12.5 Permit to Work
- 12.6 Limitation of Access
- 12.7 Sanction for Test
- 12.8 describe the typical information contained in a Permit to Work
- 12.9 identify the range of customers encountered whilst working in the Power Sector
- 12.10 state the methods by which technical information can be communicated
- 12.11 describe the purpose of maintaining accurate system records
- 12.12 state how technical information can be recorded and stored
- 12.13 describe the importance of reporting technical information inconsistencies or inaccuracies to relevant parties
- 12.14 explain the importance of effective communication to maintain good relationships with customers.

## Unit 502

## Mathematics, mechanical and electrical theory in power engineering

<b>Level:</b>	5
<b>Credit value:</b>	12
<b>GLH:</b>	120
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by EUSkills
<b>Aim:</b>	<p>The learner will be able to demonstrate:</p> <ul style="list-style-type: none"><li>- an understanding of the practical engineering application of addition, subtraction, division, multiplication, basic transposition and trigonometry</li><li>- an understanding of mathematical calculations in a power engineering environment</li><li>- an understanding of mechanical engineering principles, materials, equipment and techniques including, movement of loads, SI units, pulleys, transposition and application of basic formulae</li><li>- an understanding of the use of mechanical engineering principles and techniques in a power engineering environment</li><li>- an understanding of basic electrical principles including AC/DC theory, electrical dangers, simple circuits, magnetism, SI units, transformers and transposition and application of basic formulae</li></ul> <p>an understanding of basic electrical principles and their application in a power engineering environment..</p>

**Assessment type** Multiple choice and short answer test

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### Learning outcome:

The learner will:

1. Demonstrate an understanding of round numbers, use scientific notation, percentages and ratios

### Assessment criteria

The learner can:

- 1.1 round a number to a given number of significant figures and/or decimal places
- 1.2 convert a number y from standard notation to scientific notation or vice versa
- 1.3 use a calculator to add or subtract or multiply or divide numbers in scientific notation
- 1.4 calculate a percentage of a quantity
- 1.5 calculate quantities linked by a given ratio and split a quantity correctly according to a given ratio.

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### **Learning outcome**

The learner will:

2. Demonstrate an understanding of areas, perimeters, volumes and surface areas of simple shapes

### **Assessment criteria**

The learner can:

- 2.1 analyse calculate areas and perimeters of squares or rectangles or triangles or circles
  - 2.2 calculate volumes and surface areas of cubes or cuboids or cylinders or (other) prisms of spheres.
- 

### **Learning outcome**

The learner will:

3. Demonstrate an understanding of scales, tables, graphs and charts

### **Assessment criteria**

The learner can:

- 3.1 extract information from a scale
  - 3.2 extract information from a table
  - 3.3 extract information from a graph
  - 3.4 extract information from a chart.
- 

### **Learning outcome**

The learner will:

4. Demonstrate an understanding of Pythagoras' Theorem and sin/cos/tan in right-angled triangles

### **Assessment criteria**

The learner can:

- 4.1 use Pythagoras' Theorem correctly to calculate an unknown side in a right-angled triangle
  - 4.2 use sine or cosine or tangent correctly to calculate an unknown side and angle in a right-angled triangle.
- 

### **Learning outcome**

The learner will:

5. Demonstrate an understanding of substitute numerical values into simple engineering formulae

### **Assessment criteria**

The learner can:

- 5.1 substitute numerical values into engineering formulae involving addition or subtraction or multiplication or division of terms, and combinations of these operations
  - 5.2 substitute numerical values into engineering formulae involving simple powers: squares or square roots or cubes or cube roots.
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### **Learning outcome**

The learner will:

6. Demonstrate an understanding of the sequence of arithmetic operations

### **Assessment criteria**

The learner can:

- 6.1 perform a sequence of arithmetic operations following the form BODMAS
  - 6.2 use a range of functions found on a calculator (non VPAM)
  - 6.3 demonstrate the use of minus sign preceding numbers and number scale.
- 

### **Learning outcome**

The learner will:

7. Define mass, force and weight

### **Assessment criteria**

The learner can:

- 7.1 describe the differences and relationship between mass, force and weight
  - 7.2 perform calculations using equations and SI units
  - 7.3 represent force as a vector quantity.
- 

### **Learning outcome**

The learner will:

8. Define the parameters of mechanical systems

### **Assessment criteria**

The learner can:

- 8.1 identify the function of gears, levers, toggles, cams, cranks and pawl and ratchet
  - 8.2 identify types of springs and their characteristics.
- 

### **Learning outcome**

The learner will:

9. Define the components of hydraulic and pneumatic systems

### **Assessment criteria**

The learner can:

- 9.1 identify hydraulic and pneumatic components
  - 9.2 describe the function of hydraulic and pneumatic components.
-

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### Learning outcome

The learner will:

10. Define statics and forces

### Assessment criteria

The learner can:

- 10.1 identify conditions for static equilibrium, parallelogram of forces, triangle of forces, polygon of forces, following:
    - a. principles of moments
    - b. frictional resistance to motion
    - c. data to determine resultants
    - d. equilibrants and reactions
  - 10.2 describe the states of equilibrium of a body and the effect of its centre of gravity in relation to overhead line structures
  - 10.3 describe the effect the width of base, weight and centre of gravity have on a body's stability.
- 

### Learning outcome

The learner will:

11. Define energy, work and power

### Assessment criteria

The learner can:

- 11.1 describe the terms energy, work and power
  - 11.2 define work as force times distance moved in the direction of the force
  - 11.3 perform calculations for energy work and power using equations and SI units.
- 

### Learning outcome

The learner will:

12. Define the parameters of material tensile strengths

### Assessment criteria

The learner can:

- 12.1 identify the tensile strength of differing conductor types given relevant data
- 12.2 identify the sag of a conductor using:

$$T = \frac{WL^2}{8S}$$

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### Learning outcome

The learner will:

13. Define the parameters of mechanical advantage

### Assessment criteria

The learner can:

13.1 describe mechanical advantage provided by the use of winches and pulley systems.

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### Learning outcome

The learner will:

14. Understand the lever principle and theorem of movement

### Assessment criteria

The learner can:

14.1 describe the lever principle and theorem of movement

14.2 explain practical application in the following : crowbars, pliers, cranes and winches of the lever principle

14.3 describe and calculate – mechanical advantage, velocity ratio and torque turning force

14.4 calculate efficiency as a percentage using input and output power or energy.

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### Learning outcome

The learner will:

15. Demonstrate an understanding of circuit technology

### Assessment criteria

The learner can:

15.1 describe electron theory and current flow

15.2 describe the basic electrical theory

15.3 define resistance

15.4 use graphs to evaluate resistive circuits

15.5 read data from graphs and evaluate their statistical relevance.

15.6 state the meaning of gradient on straight-line graphs

15.7 plot graphs showing:

a. inverse relationships

b. graphs of resistance

c. cross-sectional area

15.8 determine resistance from dimensions and resistivity

15.9 state the effect of temperature on the resistance of common conducting and insulating materials

15.10 use graphs to show what is meant by positive and negative temperature coefficients and indicate their uses

15.11 state the effects of applying a DC source to a resistance with respect to Ohm's Law

15.12 outline the difference between:

a. series

b. parallel

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- c. series/parallel resistive circuits
  - 15.13 explain the meaning of voltage drop relative to conductors / cables
  - 15.14 determine the voltage drop created by the simple connection of combinations of resistors
  - 15.15 determine the current, voltage and power in circuits (and parts of circuits) formed by simple combinations of resistors
  - 15.16 state the importance of voltage rating in respect to conductors, cables and transformers
  - 15.17 identify the constructional features of the following:
    - a. parallel plate capacitor
    - b. variable and semi-variable air-spaced
    - c. solid dielectric types of capacitor
  - 15.18 describe the principles and effect of capacitance relative to conductors / cables
  - 15.19 describe the safety, charge and discharge characteristics of a capacitor relative to conductors / cables
  - 15.20 describe the principles and effect of inductance relative to conductors / cables / steelwork.
- 

### **Learning outcome**

The learner will:

- 16. Demonstrate an understanding of magnetism and electromagnetism

### **Assessment criteria**

The learner can:

- 16.1 describe the theory relating to magnetic fields and their effects on overhead and underground cables
  - 16.2 describe the characteristics of magnets
  - 16.3 describe the laws relating to their resultant magnetic fields
  - 16.4 state the relationship between magnetic field strength and relative areas of magnetic poles
  - 16.5 explain electromagnetism
  - 16.6 identify what happens to a magnetic field when a conductor carries current in relation to transformers
  - 16.7 describe the forces exerted on a current carrying conductor
  - 16.8 describe how magnetic forces can be reduced on underground and overhead cables
  - 16.9 describe the dangers of switching inductive circuits
  - 16.10 describe the movement caused to an armature when applying a DC current to a coil
  - 16.11 with reference to given sketches, identify how magnetic shielding is provided in power engineering plant and apparatus.
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### **Learning outcome**

The learner will:

- 17. Demonstrate an understanding of transformers

### **Assessment criteria**

The learner can:

- 17.1 describe the operation and construction of a variety of power transformers
  - 17.2 identify transformers from given sketches
  - 17.3 identify the laminations, core, limb and yoke and state the function of each feature
  - 17.4 compare hysteresis and eddy current losses
  - 17.5 compare the construction of the auto-transformers and double-wound transformers
-

- 17.6 describe the operation and construction of instrument transformers
- 17.7 differentiate between iron and copper losses
- 17.8 state the relationship between input, output and losses
- 17.9 describe how losses may be reduced with respect to laminating the iron core
- 17.10 carry out basic mathematical analysis on transformers and perform simple calculations on input, output and losses
- 17.11 use percentages, when defining efficiency and losses within a transformer
- 17.12 perform the calculations involving current, voltage and turns based on an ideal transformer using the equation below in relation to transformer tap changers.

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$$

## Unit 503

## Power engineering electrical networks, plant and apparatus

<b>Level:</b>	5
<b>Credit value:</b>	
<b>GLH:</b>	
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by EUSkills
<b>Aim:</b>	<ul style="list-style-type: none"><li>•</li></ul>

**Assessment type** Multiple choice test

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### Learning outcome:

The learner will:

1. Demonstrate an understanding of power generation

### Assessment criteria

The learner can:

- 1.1 list the energy sources that can be used when generating electricity
- 1.2 describe how energy is converted into electrical power in the generation process using a range of energy sources
- 1.3 state why power stations are interconnected and the advantages of interconnection
- 1.4 identify the relationship between generation, transmission and distribution companies within the UK
- 1.5 describe the function of the Electricity Regulator in the UK.
- 1.6 describe the reasons for high voltage transmission and lower voltage distribution
- 1.7 describe the transmission to distribution process from high voltage to low voltage and identify the common voltage levels at each transitional stage
- 1.8 describe the function of a step down transformer in the transmission and distribution of electricity
- 1.9 describe the function of a step up transformer in the transmission and distribution of electricity.

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## Learning outcome

The learner will:

2. Demonstrate an understanding of power transmission and distribution

## Assessment criteria

The learner can:

- 2.1 describe the advantages and disadvantages of using overhead line conductors to transmit / distribute electricity
- 2.2 describe the advantages and disadvantages of using underground cables to transmit / distribute electricity
- 2.3 describe the term Protective Multiple Earthing (PME)
- 2.4 describe the term Separate Neutral Earthing (SNE / TNS)
- 2.5 describe the construction and application of high voltage fuses used to protect networks
- 2.6 describe the construction and application of low voltage fuses used to protect networks
- 2.7 explain the usage of protection schemes on electrical networks.

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## Learning outcome

The learner will:

3. Demonstrate an understanding of electrical plant and apparatus

## Assessment criteria

The learner can:

- 3.1 state the constructional features and cooling arrangements of distribution and transmission transformers
- 3.2 describe the relationship between a transformer's ratio of primary and secondary windings and how they affect the output voltage
- 3.3 state the function of a transformer tap changer
- 3.4 describe the function of the following types of apparatus:
  - a. voltage transformer
  - b. current transformer
  - c. liquid earthing resistor
  - d. fault thrower
- 3.5 describe the function of the following types of electrical plant and apparatus:
  - a. circuit-breakers
  - b. switches
  - c. isolators
  - d. busbars
  - e. switch fuse
- 3.6 describe the constructional features and the principles of switchgear operation
- 3.7 identify electrical plant and apparatus symbols on a given network diagram
- 3.8 state the function of high voltage surge arrestors
- 3.9 describe the purpose of earthing plant and apparatus
- 3.10 identify the methods for measuring the earth resistance value of plant and apparatus
- 3.11 state the importance of achieving the correct resistance value when testing earth resistance values
- 3.12 describe how fuses are used to protect electrical plant and apparatus
- 3.13 describe what is meant by the term 'fuse rating'

3.14 interpret a fuses rating and characteristics from given specification data.

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### **Learning outcome**

The learner will:

4. Demonstrate an understanding of electrical network operations

### **Assessment criteria**

The learner can:

- 4.1 identify electrical plant and apparatus symbols on a given network diagram
- 4.2 describe the characteristics and function of electrical power networks in relation to:
  - a. radial circuits
  - b. ring circuits
  - c. feeder circuits
- 4.3 describe the methods of sectionalising a network
- 4.4 describe the common causes and types of network faults
- 4.5 describe the basic procedures for carrying out the isolation of :
  - a. a low voltage overhead line operating under 1000v
  - b. a high voltage overhead line operating over 1000v
  - c. a low voltage underground cable operating under 1000v
  - d. a high voltage underground cable operating over 1000v
- 4.6 describe the purpose of safety documentation in a power engineering environment
- 4.7 describe when each of the following safety documents would be used
  - a. Permit to Work
  - b. Limitation of Access / Limited Work Certificate
  - c. Sanction for Test
- 4.8 describe the basic roles and responsibilities of persons carrying out operations on an electrical network
- 4.9 state the purpose of network protection
- 4.10 list the types of protective systems used to protect electrical networks
- 4.11 state the advantages of carrying out network operations using remotely operated equipment
- 4.12 describe the methods by which network equipment can be remotely operated.

## Unit 504

## Power engineering: cables, sub stations and overhead lines

<b>Level:</b>	5
<b>Credit value:</b>	
<b>GLH:</b>	
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by EUSkills
<b>Aim:</b>	The learner will be able to demonstrate an understanding of the types and characteristics of: <ul style="list-style-type: none"><li>• common cables and joints, including causes and consequences of common faults</li><li>• the types and characteristics of common substation plant and apparatus including causes and consequences of common faults</li><li>• common overhead line plant and apparatus including causes and consequences of common faults.</li></ul>

**Assessment type** Multiple choice test

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### Learning outcome:

The learner will:

1. Demonstrate an understanding of underground cables

### Assessment criteria

The learner can:

- 1.1 state the types of underground cables used in UK Electrical Power Networks
- 1.2 describe the construction of the following types of cable including their core, insulation, sheathing and armouring arrangements
- 1.3 describe the common types and usage of joint used in underground cable installations
- 1.4 describe the advantages and disadvantages of different insulation materials
- 1.5 identify the electrical ratings of cables from given specifications / charts
- 1.6 describe the factors which affect the rating of a cable
- 1.7 describe the effects of electric stress on underground cables
- 1.8 explain how electrical stress can be reduced and controlled in underground cables.

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### Learning outcome

The learner will:

2. Demonstrate an understanding of underground cable installations

### Assessment criteria

The learner can:

- 2.1 state the requirements of the health and safety guidance note HSG 47 in relation to the safe working methods of cable identification, location and excavation
- 2.2 state the codes of practice and legal requirements that must be followed when carrying out cable laying activities
- 2.3 explain the advantages and disadvantages of direct lay and draw-in systems
- 2.4 state the factors to be recorded when a cable is laid
- 2.5 describe the benefits of keeping cable records and data
- 2.6 interpret and identify given information from cable plans / records
- 2.7 identify the hazards in the usage of cold pour resin in jointing activities
- 2.8 describe the precautions to be taken when handling cold pour resins.

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### Learning outcome

The learner will:

3. Demonstrate an understanding of underground cable testing and common faults

### Assessment criteria

The learner can:

- 3.1 describe the term 'phasing out' when jointing cables
- 3.2 describe the purpose for using test lamps when jointing cables
- 3.3 describe the purpose of bonding underground cables when jointing cables
- 3.4 state the causes of common cable faults
- 3.5 describe the meaning of the given terms:
  - a. open circuit
  - b. short circuit
  - c. earth faults
  - d. high resistance
- 3.6 describe the reason for 'cable spiking' an underground cable
- 3.7 describe the types and purpose of electrical testing when carrying out jointing activities.

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### Learning outcome

The learner will:

4. Demonstrate an understanding of substation installations

### Assessment criteria

The learner can:

- 4.1 identify the typical plant and apparatus used in a primary and secondary sub-station installations

- 4.2 describe the function of plant and apparatus used in primary and secondary sub-station installations
  - 4.3 describe the type and use of tap-changers in relation to substation installations
  - 4.4 describe the primary reason for the earthing of the neutral point in high voltage and low voltage systems
  - 4.5 describe the purpose of neutral earthing resistors
  - 4.6 describe the purpose of an earthing transformer
  - 4.7 explain the reason for bonding and earthing of metalwork
  - 4.8 describe the purpose of a Fault Thrower Switch (FTS)
  - 4.9 describe the reason for measuring the earth resistance value of earth electrodes in substation installations
  - 4.10 describe the meaning of the terms:
    - a. earth resistance
    - b. earth resistivity
    - c. earth fault loop impedance
  - 4.11 interpret basic substation installation connections using given single line diagrams
  - 4.12 describe the reasons for interlock systems and mechanisms used in substation installations
  - 4.13 differentiate between the use of a bus section and bus coupler switches.
- 

### **Learning outcome**

The learner will:

5. Demonstrate an understanding of substation insulating mediums

### **Assessment criteria**

The learner can:

- 5.1 state the types of insulating mediums used in substation plant and apparatus
  - 5.2 describe the function of insulating mediums used in substation plant and apparatus
  - 5.3 describe the purpose of testing insulating mediums in electrical plant and apparatus.
- 

### **Learning outcome**

The learner will:

6. Demonstrate an understanding of substation transformer protection

### **Assessment criteria**

The learner can:

- 6.1 describe the construction and operation of a Buchholz relay
  - 6.2 describe the construction and principles of transformer winding temperature
  - 6.3 state the reasons for earthing the core and secondary windings in voltage and current transformers.
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### **Learning outcome**

The learner will:

7. Demonstrate an understanding of substation maintenance
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### **Assessment criteria**

The learner can:

- 7.1 describe the advantages of preventative maintenance.
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### **Learning outcome**

The learner will:

8. Demonstrate an understanding of overhead lines

### **Assessment criteria**

The learner can:

- 8.1 explain statutory consents and notices and the procedures to be followed in the planning of overhead lines
  - 8.2 outline topographical features that effect the routing of overhead lines
  - 8.3 describe way-leave procedures (right grantors, notices, access, tree preservation orders, damage and compensation) in relation of overhead line planning
  - 8.4 compare the advantages and disadvantages of different types of overhead line support and identify the differing voltage ranges they may support
  - 8.5 in relation to overhead line design, describe the purpose of different support configurations and associated items
  - 8.6 describe the construction and characteristics of a range of overhead line conductors
  - 8.7 state the standard sizes, names and the typical voltage for which they are used, for a range of common overhead line conductors
  - 8.8 describe the purpose of overhead line conductor joints and the crucial procedures of conductor preparation and connection
  - 8.9 state the regulatory conductor ground clearances and conductor spacing for a range of common overhead line voltages
  - 8.10 state, in general terms, the effect on conductors of span length, tension, temperature, wind and ice
  - 8.11 state the constructional features for given types of insulator and state their purpose
  - 8.12 describe the purpose and effect of applying earthing devices to an overhead line when it has been isolated.
- 

### **Learning outcome**

The learner will:

9. Demonstrate an understanding of common faults on overhead lines

### **Assessment criteria**

The learner can:

- 9.1 state the typical causes and symptoms of common faults on overhead lines
- 9.2 in relation to overhead lines, explain given overhead line terms and their possible cause.

## Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on [www.cityandguilds.com](http://www.cityandguilds.com).

**City & Guilds Centre Manual** contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

**Our Quality Assurance Requirements** encompasses all of the relevant requirements of key regulatory documents such as:

- Regulatory Arrangements for the Qualifications and Credit Framework (2008)
- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

**Access to Assessment & Qualifications** provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **centre homepage** section of the City & Guilds website also contains useful information on such things as:

- **Walled Garden:** how to register and certificate candidates on line
- **Events:** dates and information on the latest Centre events
- **Online assessment:** how to register for e-assessments.

**Centre Guide – Delivering International Qualifications** contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve ‘approved centre’ status, or to offer a particular qualification. Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

### ***Linking to this document from web pages***

We regularly update the name of documents on our website, therefore in order to prevent broken links we recommend that you link to our web page that the document resides upon, rather than linking to the document itself.

## Useful contacts

<b>UK learners</b> General qualification information	<b>E: <a href="mailto:learnersupport@cityandguilds.com">learnersupport@cityandguilds.com</a></b>
<b>International learners</b> General qualification information	<b>E: <a href="mailto:intcg@cityandguilds.com">intcg@cityandguilds.com</a></b>
<b>Centres</b> Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	<b>E: <a href="mailto:centresupport@cityandguilds.com">centresupport@cityandguilds.com</a></b>
<b>Single subject qualifications</b> Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	<b>E: <a href="mailto:singlesubjects@cityandguilds.com">singlesubjects@cityandguilds.com</a></b>
<b>International awards</b> Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	<b>E: <a href="mailto:intops@cityandguilds.com">intops@cityandguilds.com</a></b>
<b>Walled Garden</b> Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	<b>E: <a href="mailto:walledgarden@cityandguilds.com">walledgarden@cityandguilds.com</a></b>
<b>Employer</b> Employer solutions including, Employer Recognition: Endorsement, Accreditation and Quality Mark, Consultancy, Mapping and Specialist Training Delivery	<b>E: <a href="mailto:business@cityandguilds.com">business@cityandguilds.com</a></b>

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## City & Guilds Group

The City & Guilds Group operates from three major hubs: London (servicing Europe, the Caribbean and Americas), Johannesburg (servicing Africa), and Singapore (servicing Asia, Australia and New Zealand). The Group also includes the Institute of Leadership & Management (management and leadership qualifications), City & Guilds Licence to Practice (land-based qualifications), the Centre for Skills Development (CSD works to improve the policy and practice of vocational education and training worldwide) and Learning Assistant (an online e-portfolio).

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**City & Guilds**  
**1 Giltspur Street**  
**London EC1A 9DD**  
**[www.cityandguilds.com](http://www.cityandguilds.com)**