

# **Certificate in Electrical Power Engineering - Distribution and Transmission (Technical Knowledge) at SCQF Level 5 (2305-17)**

February 2021, Version 1.0

**Qualification Handbook**

## Qualification at a glance

<b>Subject area</b>	Electrical power engineering
<b>City &amp; Guilds number</b>	2305
<b>Age group approved</b>	16+
<b>Entry requirements</b>	None
<b>Assessment</b>	Multiple choice and short answer test
<b>Approvals</b>	Automatic Approval
<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 code</b>
Certificate in Electrical Power Engineering - Distribution and Transmission (Technical Knowledge) at SCQF Level 5	2305-17	R661 04

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# 1 Introduction

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

Area	Description
Who is the qualification for?	This qualification is for those in the power industry. They could be undertaking a Modern Apprenticeship, wishing to gain knowledge and progress to a more advanced role.
What does the qualification cover?	These qualifications allow candidates to learn, develop and practise their knowledge and understanding for employment and career progression in the power industry.
What opportunities for progression are there?	They allow candidates to progress into employment or onto management opportunities.
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 is mandated in the Power Industry Distribution and Transmission apprenticeships at Level 5.

## Structure

To achieve the Certificate in Electrical Power Engineering - Distribution and Transmission (Technical Knowledge) at SCQF Level 5, learners must achieve all units listed in the table below.

City & Guilds unit number	Unit title	SCQF Level	SCQF Credit Value
561	Understand legislation in the power industry	5	7
562	Mathematics, mechanical and electrical theory in power engineering	5	12
563	Power engineering electrical networks, plant and apparatus	5	9
564	Power engineering: cables, sub stations and overhead lines	5	9

## 2 Centre requirements

### Approval

All centres previously approved to offer the 2343-17 Certificate in Electrical Power Engineering – Distribution and Transmission (Technical Knowledge) at SCQF Level 5 qualification will be given automatic approval to offer 2305-17 Certificate in Electrical Power Engineering – Distribution and Transmission (Technical Knowledge) at SCQF Level 5.

Automatic approval is available for 12 months from the launch of the qualification. After this time, the qualification is subject to the standard Qualification Approval Process. It is the centre's responsibility to check that automatic approval is still current at the time of application.

Centres not previously offering the 2343-17 qualification will need to apply for qualification approval through the standard approval process.

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:

#### Assessors:

- must hold, or be working towards, valid assessor qualifications as defined by the Qualification Regulator
- must be occupationally competent in the units they are assessing. Centres must evidence that the assessor has achieved the award (or equivalent), at or above the level they are

assessing. Alternatively, they must provide supporting evidence that they are able to make valid judgments through experience built up by working in the industry

- must have a working knowledge of the qualification and a full understanding of that part of the award for which they have responsibility for
- must demonstrate current evidence of continuing professional development in a relevant area of practice.

Internal verifiers:

- must hold a valid internal verifier qualification or be working towards suitable qualifications for internal verification, as defined by the Qualification Regulator(s)
- must be occupationally competent in the units they are assessing. Centres must evidence that the internal verifier has achieved the award (or equivalent), at or at or above the level they are verifying, or provide supporting evidence that they are able to make valid judgments
- must have a working knowledge of the qualifications they are internally verifying
- must be either working in the appropriate sector itself OR they must be able to demonstrate they possess practical and up-to-date knowledge of current working practices appropriate to the sector in which they are carrying out verification activities
- must demonstrate current evidence of continuing professional development in a relevant area of practice

External verifiers:

- must be familiar with the industry; have up-to-date working knowledge /experience of the technical processes and terminology for which they provide external verification. If appropriate, this experience could be evidenced through professional registration
- must hold valid qualifications in assessment and internal verification and hold, or be working towards valid qualifications for external verification, as defined by the Qualification Regulator
- must demonstrate current evidence of continuing professional development in a relevant area of practice

Centre staff may undertake more than one role, e.g 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 qualifications successfully.

Age restrictions

City & Guilds cannot accept any registrations for candidates under 16 as these qualifications are 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

City & Guilds has written the following assessments that must be used to assess this qualification:

Assessment Types			
Unit	Title	Assessment method	Where to obtain assessment materials
561	Understand legislation in the power industry	Multiple choice paper 561  This is a paper-based multiple-choice paper that is internally marked and externally verified.	Assessment pack downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
562	Mathematics, mechanical and electrical theory in power engineering	Multiple choice and short answer questions paper 562  This is a paper-based multiple-choice and short answer question paper that is internally marked and externally verified.	Assessment pack downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
563	Power engineering electrical networks, plant and apparatus	Multiple choice paper 563  This is a paper-based multiple-choice paper that is internally marked and externally verified.	Assessment pack downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>
564	Power engineering: cables, sub stations and overhead lines	Multiple choice paper 564  This is a paper-based multiple-choice paper that is internally marked and externally verified.	Assessment pack downloadable from <a href="http://www.cityandguilds.com">www.cityandguilds.com</a>

### **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**

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 will follow.

## Unit 561

## Understand legislation in the power industry

<b>SCQF Level:</b>	Level 5
<b>Credit value:</b>	7
<b>Contact Hours</b>	65
<b>On the job / Self study</b>	5
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by Energy & Utility Skills.
<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>

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### Learning outcomes:

The learner will be able to:

1. demonstrate an understanding of relevant health and safety legislation
2. demonstrate an understanding of relevant health and safety procedures
3. understand the risk assessment process
4. understand the importance of Personal Protective Equipment (PPE)
5. understand the causes of accidents
6. understand the storage and inspection of lifting equipment
7. understand about working at height
8. understand about working in confined spaces
9. understand fire prevention
10. understand the dangers of asbestos
11. understand the importance of handling and disposing of waste
12. understand the importance of working effectively and efficiently
13. demonstrate an understanding of using and communicating technical information

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### Learning outcome:

The learner will be able to:

1. demonstrate an understanding of relevant health and safety legislation

### Assessment criteria

The learner can:

- 1.1 describe 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 and Fire Precautions (workplace) 2003
- 1.2 outline 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. Control of Noise at work Regulations 2005
  - e. Construction (Design and Management) Regulations 2015

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### Learning outcome:

The learner will be able to:

2. demonstrate an understanding of relevant health and safety procedures

### 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 information relating to safety policies, codes of practice and procedures can be found
- 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 be able to:

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
- 

### Learning outcome:

The learner will be able to:

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.
- 

### Learning outcome:

The learner will be able to:

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) 2013
  - 5.3 state appropriate actions to be taken in the event of an injury / accident
  - 5.4 describe the effects of electric shock
  - 5.5 describe precautions that can be taken to prevent electric shock
  - 5.6 state the difference between direct and indirect electrical contact
- 

### Learning outcome:

The learner will be able to:

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 terms:
    - 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 be able to:

7. understand about working at height

### Assessment criteria

The learner can:

- 7.1 describe hazards associated with working at height
  - 7.2 describe preventative measures used to reduce the hazards of working at height
  - 7.3 3. outline the requirements of the Construction Regulations with regard to work at height.
- 

### Learning outcome:

The learner will be able to:

8. understand about working in confined spaces

### Assessment criteria

The learner can:

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

### Learning outcome:

The learner will be able to:

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 firefighting equipment for different types of fires
  - 9.4 describe the purpose and potential hazards of automatic firefighting equipment
  - 9.5 outline the requirements of the Fire Safety Regulations 2005.
- 

#### Learning outcome:

The learner will be able to:

10. understand the dangers of asbestos

#### Assessment criteria

The learner can:

- 10.1 outline the different uses and properties of asbestos in the power industry
  - 10.2 describe potential risks to the health of workers exposed to asbestos
  - 10.3 describe situations/work environments where asbestos might be found
  - 10.4 describe methods for controlling and minimising the risk of exposure to asbestos
  - 10.5 describe emergency and decontamination procedures for dealing with asbestos
  - 10.6 outline the requirements of the Control of Asbestos Regulations 2012
- 

#### Learning outcome:

The learner will be able to:

11. understand the importance of handling and disposing of waste

#### Assessment criteria

The learner can:

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

#### Learning outcome:

The learner will be able to:

12. understand the importance of working effectively and efficiently

#### Assessment criteria

The learner can:

- 12.1 identify methods to assess own levels of competence and learning needs
  - 12.2 describe how to plan and implement a timetable for developing competence and improve their personal performance
  - 12.3 describe the principles and importance of team working
  - 12.4 state the importance of effective communication in a working environment
  - 12.5 describe how to plan work activities effectively and efficiently
  - 12.6 list types of information needed to plan tasks effectively
  - 12.7 outline basic principles for dealing with problems in planned activities
  - 12.8 describe basic methods to evaluate the success of a completed planned activity
-



- 12.9 outline the benefits of improving working practices and procedures
  - 12.10 describe the importance of meeting customer expectations
  - 12.11 describe the impact of interruptions and loss of supply to customers
- 

### Learning outcome:

The learner will be able to:

- 13. demonstrate an understanding of using and communicating technical information

### Assessment criteria

The learner can:

- 13.1 describe types of written technical information used in a power engineering environment
- 13.2 describe types of diagrammatic / pictorial technical information used in a power engineering environment
- 13.3 identify types of technical information that can be gained from geographic diagrams/site plans
- 13.4 describe the purpose of safety documentation used in the power sector including:
  - a. Permit to Work
  - b. Limitation of Access
  - c. Sanction for Test
- 13.5 describe typical information contained in a Permit to Work
- 13.6 identify the range of customers encountered whilst working in the Power Sector
- 13.7 state methods by which technical information can be communicated
- 13.8 describe the purpose of maintaining accurate system records
- 13.9 state how technical information can be recorded and stored
- 13.10 describe the importance of reporting technical information inconsistencies or inaccuracies to relevant parties
- 13.11 explain the importance of effective communication to maintain good relationships with customers.

## Unit 562

## Mathematics, mechanical and electrical theory in power engineering

<b>SCQF Level:</b>	Level 6
<b>Credit value:</b>	12
<b>Contact Hours</b>	110
<b>On the job / Self study</b>	10
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by Energy & Utility Skills
<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><li>• an understanding of basic electrical principles and their application in a power engineering environment.</li></ul>

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### Learning outcomes:

The learner will be able to:

1. demonstrate an understanding of round numbers, use scientific notation, percentages and ratios
2. demonstrate an understanding of areas, perimeters, volumes and surface areas of simple shapes
3. demonstrate an understanding of scales, tables, graphs and charts
4. demonstrate an understanding of Pythagoras' Theorem and sin/cos/tan in right-angled triangles
5. demonstrate an understanding of substitute numerical values into simple engineering formulae

6. demonstrate an understanding of the sequence of arithmetic operations
  7. define mass, force and weight
  8. define the parameters of mechanical systems
  9. define the components of hydraulic and pneumatic systems
  10. define statics and forces
  11. define energy, work and power
  12. define the parameters of material tensile strengths
  13. define the parameters of mechanical advantage
  14. understand the lever principle and theorem of movement
  15. demonstrate an understanding of circuit technology
  16. demonstrate an understanding of magnetism and electromagnetism
  17. demonstrate an understanding of transformers
- 

#### 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 from standard notation to scientific notation or vice versa
  - 1.3 use a calculator to add, subtract, multiply and divide numbers in scientific notation
  - 1.4 calculate percentages of quantities
  - 1.5 calculate quantities linked by ratios and split quantities correctly by ratios
- 

#### 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 calculate areas and perimeters of squares, rectangles, triangles and circles
  - 2.2 calculate volumes and surface areas of cubes, cuboids, cylinders and (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 scales
  - 3.2 extract information from tables
  - 3.3 extract information from graphs
  - 3.4 extract information from charts
- 

### 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 to calculate an unknown side in a right-angled triangle
  - 4.2 use sine or cosine or tangent 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, subtraction, multiplication, division of terms, and combinations of these operations
  - 5.2 substitute numerical values into engineering formulae involving simple powers: squares, square roots, cubes and cube roots
- 

### Learning outcome:

The learner will:

6. demonstrate an understanding of the sequence of arithmetic operations

### Assessment criteria

The learner can:

- 6.1 perform 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
-

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**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
- 

**Learning outcome:**

The learner will:

10. define statics and forces

**Assessment criteria**

The learner can:

- 10.1 explain the importance of 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 multiplied by 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 explain the importance of identify the tensile strength of material types given relevant data
- 12.2 identify the sag of a conductor using:

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

**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
- 

**Learning outcome:**

The learner will:

14. understand the lever principle and theorem of movement
-

### Assessment criteria

The learner can:

- 14.1 explain the importance of describe the lever principle and theorem of movement
- 14.2 explain practical applications of the lever principle
- 14.3 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 the basic principles of electron theory and current flow
- 15.2 define electrical resistance and impedance
- 15.3 use graphs to evaluate resistive circuits
- 15.4 interpret data from graphs and evaluate their statistical relevance.
- 15.5 Define the meaning of gradients on straight-line graphs
- 15.6 plot graphs showing:
  - a. inverse relationships
  - b. graphs of resistance
  - c. cross-sectional area
- 15.7 determine resistance from material dimensions and resistivity
- 15.8 state the effect of temperature on the resistance of common conducting and insulating materials
- 15.9 use graphs to show positive and negative temperature coefficients indicating their uses
- 15.10 state the principles of Ohm's Law in respect of AC/DC sources
- 15.11 outline the difference between:
  - a. series
  - b. parallel
  - c. series/parallel resistive circuits
- 15.12 explain the meaning of voltage drop relative to conductors / cables
- 15.13 determine voltage drop created by simple connection of combinations of resistors
- 15.14 determine current, voltage and power in circuits (and parts of circuits) formed by simple combinations of resistors
- 15.15 state the importance of voltage rating in respect to conductors, cables and transformers
- 15.16 identify the constructional features of the following:
  - a. parallel plate capacitor
  - b. variable and semi-variable air-spaced
  - c. solid dielectric types of capacitor
- 15.17 describe the principles and effect of capacitance relative to conductors/cables
- 15.18 describe safety, charge and discharge characteristics of capacitors relative to conductors/cables
- 15.19 describe the principles and effect of inductance relative to conductors / cables/steelwork.

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### Learning outcome:

The learner will:

16. demonstrate an understanding of magnetism and electromagnetism

### Assessment criteria

The learner can:

- 16.1 explain the importance of 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 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 identify using sketches 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 power transformers
- 17.2 identify transformer types from sketches
- 17.3 identify the function of transformer features; laminations, core, limb and yoke
- 17.4 compare hysteresis and eddy current losses
- 17.5 compare the construction of 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 to define efficiency and losses within a transformer
- 17.12 perform 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 563

## Power engineering electrical networks, plant and apparatus

<b>SCQF Level:</b>	Level 5
<b>Credit value:</b>	9
<b>Contact hours</b>	80
<b>On the job / Self study</b>	10
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by Energy & Utility Skills
<b>Aim:</b>	<p>The learner will be able to demonstrate:</p> <ul style="list-style-type: none"><li>• an understanding of power engineering electrical networks including; generation, transmission, distribution and transformation of system voltages</li><li>• an understanding of power engineering electrical plant and apparatus including the properties and purpose of transformers, switchgear, earthing devices, voltage and load control and automated equipment</li><li>• an understanding of the types, properties and use of power engineering electrical transmission and distribution plant and apparatus</li><li>• an understanding of power engineering common network configurations, terms and characteristics, switching operations, safety documentation and protection.</li></ul>

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### Learning outcomes:

The learner will be able to:

1. demonstrate an understanding of power generation including distributed generation
2. demonstrate an understanding of power transmission and distribution
3. demonstrate an understanding of electrical plant and apparatus
4. demonstrate an understanding of electrical network operations

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### Learning outcome:

The learner will:

1. demonstrate an understanding of power generation including distributed generation

### Assessment criteria

The learner can:

- 1.1 list 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 LV/HV power stations systems are interconnected and the advantages of interconnection
- 1.4 identify the relationship between generation, transmission and distribution arrangements within the UK
- 1.5 describe the function of the Electricity Regulator in the UK.
- 1.6 describe 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 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 specification data.
- 

## Learning outcome:

The learner will:

4. demonstrate an understanding of electrical network operations

## Assessment criteria

The learner can:

- 4.1 explain the importance of identify electrical plant and apparatus symbols on network diagrams
  - 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 methods of sectionalising a network
  - 4.4 describe common causes and types of network faults
  - 4.5 describe 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 describe the basic roles and responsibilities of persons carrying out operations on an electrical network
- 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 564

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

<b>SCQF Level:</b>	Level 5
<b>Credit value:</b>	9
<b>Contact hours</b>	80
<b>On the job / Self study</b>	10
<b>Endorsement by a sector or regulatory body:</b>	This unit is endorsed by Energy & Utility Skills
<b>Aim:</b>	<p>The learner will be able to demonstrate an understanding of the types and characteristics of:</p> <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>

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### Learning outcomes:

The learner will be able to:

1. demonstrate an understanding of underground cables
2. demonstrate an understanding of underground cable installations
3. demonstrate an understanding of underground cable testing and common faults
4. demonstrate an understanding of substation installations
5. demonstrate an understanding of substation insulating mediums
6. demonstrate an understanding of substation transformer protection
7. demonstrate an understanding of substation maintenance
8. demonstrate an understanding of overhead lines
9. demonstrate an understanding of common faults on overhead lines

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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 common types of underground cables used in electrical power networks including distributed power networks
  - 1.2 describe the construction of commonly used underground cable types including their core, insulation, sheathing and armouring arrangements
  - 1.3 describe the common types and usage of joints 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 specifications / charts
  - 1.6 describe factors that effect 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.
- 

### Learning outcome:

The learner will:

2. demonstrate an understanding of underground cable installations

### Assessment criteria

The learner can:

- 2.1 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 information from cable plans / records
  - 2.7 describe types of underground plant apparatus used in underground power networks
- 

### 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 types and purpose of electrical testing when carrying out jointing activities
  - 3.2 describe the purpose of bonding underground cables when jointing cables
  - 3.3 state causes of common cable faults
  - 3.4 describe the meaning of the terms:
    - a. open circuit
    - b. short circuit
    - c. earth faults
    - d. high resistance
-

3.5 describe reasons for 'cable spiking' an underground cable

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**Learning outcome:**

The learner will:

4. demonstrate an understanding of substation installations

**Assessment criteria**

The learner can:

- 4.1 describe the purpose of plant and apparatus in primary and secondary substation installations, including:
    - a. circuit breakers
    - b. tap changers
    - c. isolators
    - d. neutral earthing resistors
    - e. fault thrower switches
    - f. earthing transformer
    - g. reactors
  - 4.2 describe the function of plant and apparatus used in primary and secondary sub-station installations
  - 4.3 describe the primary reason for the earthing of the neutral point in high voltage and low voltage systems
  - 4.4 explain the reason for bonding and earthing of metalwork
  - 4.5 describe the reason for measuring the earth resistance value of earth electrodes in substation installations
  - 4.6 describe the meaning of the terms:
    - a. earth resistance
    - b. earth resistivity
    - c. earth fault loop impedance
  - 4.7 interpret basic substation installation connections using single line diagrams
  - 4.8 describe the reasons for interlock systems and mechanisms used in substation installations
  - 4.9 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 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
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### 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

### Assessment criteria

The learner can:

- 7.1 describe advantages and disadvantages of substation inspection and preventative maintenance procedures

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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 describe common types of overhead line plant and apparatus and their purpose
- 8.3 outline topographical features that effect the routing of overhead lines
- 8.4 describe way-leave procedures in relation to overhead planning, including:
  - a. right grantors
  - b. notices
  - c. access
  - d. tree preservation orders
  - e. damage and compensation
- 8.5 compare advantages and disadvantages of different types of overhead line support and identify the differing voltage ranges they may support
- 8.6 describe the purpose of different support configurations and associated items in relation to overhead line design
- 8.7 describe the construction and characteristics of a range of overhead line conductors
- 8.8 state the regulatory conductor ground clearances and conductor spacing for common overhead line voltages

- 8.9 state the effects on conductors of span length, tension, temperature, wind and ice loading
  - 8.10 state the constructional features and purpose for types of insulator
  - 8.11 describe the purpose and effect of applying earthing devices to an overhead line when it has been isolated.
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**Learning outcome:**

The learner will:

- 9. demonstrate an understanding of common faults on overhead lines

**Assessment criteria**

The learner can:

- 9.1 state typical causes and symptoms of common faults on overhead lines
-

## 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.

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.

[www.cityandguilds.com](http://www.cityandguilds.com)

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## Useful contacts

### UK learners

General qualification information

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**E: [learnersupport@cityandguilds.com](mailto:learnersupport@cityandguilds.com)**

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### International learners

General qualification information

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**E: [intcg@cityandguilds.com](mailto:intcg@cityandguilds.com)**

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### Centres

Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results

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**E: [centresupport@cityandguilds.com](mailto:centresupport@cityandguilds.com)**

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### Single subject qualifications

Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change

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**E: [singlesubjects@cityandguilds.com](mailto:singlesubjects@cityandguilds.com)**

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### International awards

Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports

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**E: [intops@cityandguilds.com](mailto:intops@cityandguilds.com)**

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### Walled Garden

Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems

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**E: [walledgarden@cityandguilds.com](mailto:walledgarden@cityandguilds.com)**

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### Employer

Employer solutions including, Employer Recognition: Endorsement, Accreditation and Quality Mark, Consultancy, Mapping and Specialist Training Delivery

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**E: [business@cityandguilds.com](mailto:business@cityandguilds.com)**

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The City & Guilds Group is a leader in global skills development. Our purpose is to help people and organisations to develop their skills for personal and economic growth. Made up of City & Guilds, City & Guilds Kineo, The Oxford Group and ILM, we work with education providers, businesses and governments in over 100 countries.

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