QUALIFICATION HANDBOOK

Level 3 Diploma in Electrical Power Engineering - Distribution and Transmission (Technical Knowledge) (2339-45)

April 2013 Version 2.1

City & Guilds

Qualification at a glance

Subject area	**Level 3 NVQ Diploma in Electrical Power Engineering – Distribution and Transmission (Technical Knowledge)**
City & Guilds number	2339
Age group approved	16-18 and 19+
Entry requirements	None
Assessment	Short Answer, Multiple Choice and Assignment
Fast track	Automatic approval
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds number	Accreditation number
Level 3 Diploma Electrical Power Engineering – Distribution and Transmission (Technical Knowledge)	2339-45	600/1221/3

Version and date	Change detail	Section
2.1 Apr 2013	Added additional information regarding unit 404	**Test specifications**

Contents

1 Introduction

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

Area	Description
Who is the qualification for?	For candidates who work in the power industry – distribution and transmission
What does the qualification cover?	Allows candidates to develop the knowledge required for employment and/or career progression in distribution and transmission.
Is the qualification part of a framework or initiative?	Serves as a knowledge component, in the Advanced Apprenticeship framework.
Who did we develop the qualification with?	This qualification was developed in association with industry employers and the sector skills council Energy & Utility Skills (EU Skills).
What opportunities for progression are there?	Allows candidates to progress into employment or to the following City & Guilds qualifications: • Level 3 Diploma in Electrical Power Engineering - Substation Plant: 500/7323/0 • Level 3 Diploma in Electrical Power Engineering - Underground Cables: 500/7324/2 • Level 3 Diploma in Electrical Power Engineering - Overhead Lines: 500/7318/7 • Level 3 Diploma in Electrical Power Engineering - Lead Substation Craftsperson: 500/7971/2 • Level 3 Diploma in Electrical Power Engineering - Lead Overhead Lines Person: 500/8007/6

Structure

To achieve the **Level 3 Diploma in Electrical Power Engineering – Distribution and Transmission (Technical Knowledge)**, learners must achieve **77** credits from the mandatory units in the table below.

Unit accreditation number	City & Guilds unit number	Unit title	Credit value
Mandatory			
L/503/1027	401	Design of plant and apparatus and principles of control systems in the power industry	15
R/503/1028	402	Supervising the use of resources in the power industry	15
Y/503/1029	403	Supervise and maintain safety in a power utility environment	15
R/602/2775	404	Employment rights and responsibilities in the energy & utility sector	2
L/503/1030	405	Electrical theory and principles in power engineering	10
R/503/1031	406	Mathematics in power engineering	12
Y/503/1032	407	Mechanical theory and principles in power engineering	8

2 Centre requirements

Approval

To offer these qualifications, new centres will need to gain both centre and qualification approval. Please refer to the *Centre Guide and Providing City & Guilds Qualifications* in Appendix 1 for further information.

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

If your centre is approved to offer the qualification Level 3 Certificate in Electrical Technical Engineering (2322-01) you can apply for the new Level 3 Diploma in Electrical Power Engineering – Distribution and Transmission (2339-45) approval via automatic approval.

Centre staffing

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

- be occupationally competent or technically knowledgeable in the area for which they are delivering training; this knowledge must be to the same level as the training being delivered
- demonstrate a high level of interpersonal and communication skills
- 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 National Occupational Standards 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.

Centre staff may undertake more than one role, e.g. tutor and assessor or internal verifier, but cannot internally verify their own assessments.

Assessors and internal verifiers

Centre staff should hold, or be working towards, the relevant Assessor/Verifier (A/V) units for their role in delivering, assessing and verifying this qualification. Alternatively an employer direct model can be used.

Continuing professional development (CPD)

Centres must support their staff, and expert witnesses where used, to ensure that they have current knowledge of the occupational area, that delivery, mentoring, training, assessment and verification is in line with best practice, and that it takes account of any national or legislative developments.

Candidate entry requirements

City & Guilds does not set entry requirements for this qualification. 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 qualification
- any units they have already completed, or credit they have accumulated which is relevant to the qualification
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the candidate fully understands the requirements of the qualification, 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 this qualification:

Description	How to access
Assessment Pack	**www.cityandguilds.com**
Centre Handbook	**www.cityandguilds.com**

4 Assessment

Summary of assessment methods

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

Unit Number	Unit Title	Assessment method	Where to obtain assessment materials
401	Design of plant and apparatus and principles of control systems in the power industry	Short Answer	**www.cityandguilds.com**
402	Supervising the use of resources in the power industry	Short Answer/ Multiple Choice	**www.cityandguilds.com**
403	Supervise and maintain safety in a power utility environment	Short Answer/ Assignment	**www.cityandguilds.com**
404	Employment rights and responsibilities in the energy & utility sector	Short Answer	**www.cityandguilds.com**
405	Electrical theory and principles in power engineering	Short Answer	**www.cityandguilds.com**
406	Mathematics in power engineering	Short Answer/ Assignment	**www.cityandguilds.com**
407	Mechanical theory and principles in power engineering	Short Answer	**www.cityandguilds.com**

Assessment strategy

Centres must be able to:

- ensure the assessment methods reflect requirements for the different types of evidence likely to be generated at appropriate levels. For example, more use of observation may be appropriate at lower levels but used less in higher levels. Observation will not be the sole method of assessment
- promote the use of high quality witness testimony as a means of adding value and reducing unnecessary bureaucracy in the assessment process. EU Skills provides further details about witness testimony.

Realistic Work Environment (RWE)

Centres wishing to operate a Realistic Work Environment (RWE) must operate an environment which reflects a real work setting. This will ensure any competence achieved in this way will be sustained in real employment. Where new National Occupational Standards are developed, EU Skills will use a decision matrix to determine the units where assessment of this type can be carried out.

The following contexts are illustrative of where assessment in a RWE might be used:

- Where demonstration of emergency shutdown and related safety procedures would be **dangerous and/or disruptive** to plant/environment/individuals; or too costly, such as total plant shutdown or dealing with spillage of dangerous substances; where **issues of confidentiality** restrict access to real work opportunities.
- Demonstrating specific aspects of the operation which rarely or never occur because of effective quality assurance systems.
- The capacity to integrate disparate knowledge to cope with unforeseen events and to solve problems.
- Aspects of working relationships and communications where no opportunity has been presented for the use of naturally occurring workplace evidence of learners' performance.

Conditions of assessment in a RWE

To undertake the assessment in a RWE the following conditions must be met:

1. Assessments must be carried out under realistic work pressures that are found in the normal industry workplace.
2. Assessments must be carried out in conditions and facilities which are typical of those encountered in the normal industry workplace.
3. The range of materials, equipment and tools that learners use must be up-to-date and be of the type routinely found in the normal industry workplace environments.
4. All work carried out should be completed in a way, and to a timescale, that is acceptable in the normal industry workplace.
5. Learners must interact with the range of personnel and contractors found in the normal industry workplace.
6. Learners must be expected to achieve a volume of work comparable to that expected in the normal work situation being replicated.

7. Learners must be given workplace responsibilities that will enable them to meet the requirements of the National Occupational Standards.
8. Learners must show their productivity reflects that found in the work situation being replicated.
9. The RWE must take legislation, regulations, codes of practice etc., which pertain to the regulated environment, into account.
10. The RWE must be managed as a real work situation.

Witness Testimony

EU Skills supports the use of witness testimony as a natural and effective way of contributing to a candidate's source of evidence of competence. Nonetheless, the quality of this type of evidence will be affected by knowledge the witness has about the vocational qualification requirements and their own competence in the occupational role.

As a minimum, a witness should be:

- fully briefed and clear about the purpose and use of the testimony
- able to demonstrate they have the necessary expertise in the occupational area for which they are providing testimony.

Expert witnesses should be:

- occupationally competent in the functions covered by the units to which they are contributing; this competence will have been gained by working in the energy and utilities sector
- maintaining their occupational competence by engaging in continuing professional development activities to keep up-to-date with developments and changes taking place within the energy and utilities sector
- working currently, or within the last year, in a post directly related to the vocational qualification units they are witnessing
- familiar with the national occupational standards and able to interpret current working practices and technologies within the area of work

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**

If candidates have completed the EU Skills ERR workbook this will be sufficient to complete unit 404 Employment rights and responsibilities in the energy & utility sector. If candidates have not completed this workbook, then the City & Guilds test will need to be completed which is available on the City & Guilds website. A copy of the completed workbook will need to be kept in the candidate's portfolio for external quality assurance purposes.

5 Units

Availability of units

They are also on The Register of Regulated Qualifications:
http://register.ofqual.gov.uk/Unit

Structure of units

These units each have the following:

- City & Guilds reference number
- unit accreditation number
- title
- level
- credit value
- learning outcomes which are comprised of a number of assessment criteria

Summary of units

Unit Number	Unit Title	Credits	Unit number
401	Design of plant and apparatus and principles of control systems in the power industry	15	L/503/1027
402	Supervising the use of resources in the power industry	15	R/503/1028
403	Supervise and maintain safety in a power utility environment	15	Y/503/1029
404	Employment rights and responsibilities in the energy & utility sector	2	R/602/2775
405	Electrical theory and principles in power engineering	10	L/503/1030
406	Mathematics in power engineering	12	R/503/1031
407	Mechanical theory and principles in power engineering	8	Y/503/1032

Unit 401 Design of plant and apparatus and principles of control systems in the power industry

UAN:	**L/503/1027**
Level:	3
Credit value:	15
GLH:	75

Learning outcome	**The learner will:**
1	Understand the design principles, operation and function of electrical transmission and distribution plant and apparatus
Assessment criteria	
The learner can:	
1.1	describe the critical design factors which determine the selection and placement of electrical power transformers on an electrical network
1.2	describe the critical design factors which determine the selection and placement of switchgear on an electrical network
1.3	describe the design criteria which determine the selection and placement of equipment on an electrical network
1.4	describe the technical specifications and factors to be taken into account when designing an electrical cable network
1.5	describe the technical specifications and factors to be taken into account when designing an electrical overhead line network
1.6	explain the technical requirements when designing earthing schemes for an electrical network.

Learning outcome	**The learner will:**
2	Understand electrical operations and control systems used on power utilities networks
Assessment criteria	
The learner can:	
2.1	describe how to manage the factors for planning a system outage
2.2	describe the information which can be gained from schematic network diagrams
2.3	describe how and where switching operations are recorded
2.4	describe the implications of supply losses in relation to the

	regulatory bodies
2.5	explain the principles of remote operation
2.6	state the hierarchy of HV switching and how automated switching relates to it
2.7	describe the advantages of electrical network remote control and automation
2.8	describe why automation is required in relation to Customer Minutes Lost and Short Interruptions.

Learning outcome	**The learner will:**
3	Understand UK electrical network monitoring and protection systems
Assessment criteria	
The learner can:	
3.1	describe the purpose of electrical network protection systems
3.2	explain why CTs and VTs are used in protection systems
3.3	describe the importance of battery supplies when used in conjunction with protection systems
3.4	explain the types and principles of fusing in network protection systems
3.5	explain the principles and use of the different types of circuit protection
3.6	explain the principles and use of the different types of transformer protection
3.7	explain the principles and purpose of SCADA systems
3.8	describe the purpose of the different types of condition monitoring.

Learning outcome	**The learner will:**
4	Understand the purpose and techniques for electrical testing and fault diagnosis
Assessment criteria	
The learner can:	
4.1	describe the purpose of the different types of testing
4.2	explain the fault diagnostic techniques used to identify and locate faults on overhead and underground systems
4.3	describe the typical cause, symptoms and effect of faults that occur on electrical systems
4.4	describe the purpose of carrying out functional checks and tests to verify rectification and restoration of systems.

Unit 402 Supervising the use of resources in the power industry

UAN:	**R/503/1028**
Level:	3
Credit value:	15
GLH:	75

Learning outcome	**The learner will:**
1	Understand techniques for organising, monitoring and controlling the use of resources in an engineering environment
Assessment criteria	
The learner can:	
1.1	describe the different types of resources required to complete power utility activities
1.2	describe the methods used to select the resources required to complete a planned power utility activity
1.3	describe the processes used to schedule and obtain resources for a planned power utility activity
1.4	describe the processes used to monitor and record resource costs for a power utility project
1.5	state the methods for recording the receipt and inspection of materials, plant, tools and equipment
1.6	explain the methods used to monitor the use of resources
1.7	describe safe methods for storage of electrical materials and equipment
1.8	describe the purpose of record-keeping
1.9	explain the methods used to record information
1.10	describe the waste disposal methods and procedures for various types of hazardous waste
1.11	describe the risk control methods and requirements for controlling the use and storage of substances which are hazardous to the environment
1.12	state the potential outcomes of not organising and controlling resources for power utility activities.

Learning outcome	The learner will:
2	Organise, monitor and control the use of resources in an engineering environment
Assessment criteria	
The learner can:	
2.1	interpret a range of power utility information to identify resource requirements
2.2	select resource requirements for a power utility activity
2.3	prepare a resource plan for a power utility activity
2.4	interpret delivery documentation, plant, utilisation sheets, and requisition orders
2.5	produce a work schedule to organise and control project resources
2.6	evaluate the advantages and disadvantages of the hire, lease or purchase of plant and equipment and their effects on project costs
2.7	describe and evaluate contingency measures to cater for changes in the work arrangements
2.8	establish the procedures for reviewing environmental impact and control measures.

Learning outcome	The learner will:
3	Understand how to produce, communicate and record technical information for a given purpose
Assessment criteria	
The learner can:	
3.1	describe how differing communication styles can impact on how information is given, received and understood
3.2	describe the methods used to record technical information for power utility activities
3.3	describe the benefits of recording technical information for a power utility project.

Learning outcome	The learner will:
4	Produce and communicate technical information
Assessment criteria	
The learner can:	
4.1	interpret technical information used in power utility documents
4.2	interpret safety related information used in power utility activities
4.3	identify potential problems and devise contingencies when in the planning stage for a power utility project
4.4	create a project plan for a power utility project
4.5	create technical information to support the implementation of a power utility project plan
4.6	prepare and verbally communicate project information to other people in the form of a presentation.

Learning outcome	The learner will:
5	Understand how to control and supervise others in a power utility environment
Assessment criteria	
The learner can:	
5.1	state the requirements of health and safety legislation in relation to work on distribution/transmission networks
5.2	describe the purpose and requirements of safety documentation used to control work on an electrical network
5.3	describe the roles and responsibilities of persons involved in work on an electrical network
5.4	list the procedures for authorising work on a power utility network
5.5	describe methods of risk assessment and the hierarchy of control measures used to control hazards in power utility working environments
5.6	describe how to monitor and control the work activities undertaken by individuals within a working party
5.7	state the methods used and the reasons for keeping others informed about activities that may affect them
5.8	describe the importance of communicating clearly and how to confirm others have understood the information they have been given
5.9	state the information required to establish the competence of operatives/contractors involved in power utility activities
5.10	state the procedures and reasons for accident reporting
5.11	describe the requirements and methods for the demarcation of work/test areas
5.12	create a method statement for a given power utility work activity
5.13	interpret drawings, specifications and instructions in order to safely control distribution / transmission electrical work activities
5.14	create a Safety Permit to achieve safety for the system with the relevant information for a given distribution or transmission work activity
5.15	describe the effects of how differing leadership styles can influence the control of others.

Unit 403 Supervise and maintain safety in a power utility environment

UAN:	**Y/503/1029**
Level:	3
Credit value:	15
GLH:	75

Learning outcome	**The learner will:**
1	Understand the principles and processes for supervising and maintaining health and safety in the workplace
Assessment criteria	
The learner can:	
1.1	explain the principles and practices to be followed when managing health and safety in the workplace
1.2	analyse work and set health and safety objectives for maintaining health and safety in the workplace
1.3	explain the methods used for communicating health and safety information to others.

Learning outcome	**The learner will:**
2	Understand the legislation to be followed to supervise and maintain health and safety in the workplace
Assessment criteria	
The learner can:	
2.1	explain the relevant health and safety legislation and how it should be applied to maintain a healthy and safe workplace.

Learning outcome	The learner will:
3 Supervise and maintain health and safety in the workplace	
Assessment criteria	
The learner can: 3.1 identify health and safety hazards present in the workplace 3.2 create plans and courses of action to achieve health and safety objectives 3.3 investigate and take remedial actions where accidents and incidents of injury and damage have occurred 3.4 conduct a record of risk assessment of hazards in the workplace and recommend control measures.	

Unit 404 Employment rights and responsibilities in the energy & utility sector

UAN:	**R/602/2775**
Level:	2
Credit value:	2
GLH:	20
Relationship to NOS:	This unit directly reflects the Employee Rights and Responsibilities (ERR) requirements of the Specification of Apprenticeship Standards for England and the Specification of Apprenticeship Standards for Wales.
Aim:	This unit is about understanding Employee Rights & Responsibilities (ERR) in the energy and utility sector.

Learning outcome	**The learner will:**
1	Know employer and employee rights, responsibilities and own organisational procedures
Assessment criteria	
The learner can:	
1.1	state employer and employee rights and responsibilities under employment law, including the Disability Discrimination Act, health & safety and other relevant legislation
1.2	state the importance of having employment rights and responsibilities
1.3	describe organisational procedures for health & safety, including documentation
1.4	describe organisational procedures for equality & diversity, including documentation
1.5	identify sources of information and advice on employment rights and responsibilities, including Access to Work and Additional Learning Support.

Learning outcome	The learner will:
2 Know factors that affect own organisation and occupation	
Assessment criteria	
The learner can: 2.1 describe the role played by own occupation within organisation and industry 2.2 describe career pathways available to them 2.3 state types of representative body related to the industry, their main roles and responsibilities and their relevance to the industry 2.4 identify sources of information and advice on own industry, occupation, training and career 2.5 describe principles, policies and codes of practice used by own organisation and industry 2.6 describe issues of public concern that affect own organisation and industry.	

Unit 405 Electrical theory and principles in power engineering

UAN:	**L/503/1030**
Level:	3
Credit value:	10
GLH:	50

Learning outcome	**The learner will:**
1	Be able to use circuit theory to determine voltage, current and resistance in direct current (DC) circuits
Assessment criteria	
The learner can: 1.1 use OHM's Law and Kirchhoff's laws in simple DC circuits 1.2 use Norton, Thevenin and maximum power transfer theorem in complex DC networks.	

Range	
1.1	Calculate current, voltage, resistance and power in relation to a power engineering context
1.2	Calculate current, voltage, resistance and power in relation to a power engineering context

Learning outcome	**The learner will:**
2	Know and understand the construction and operation of DC machines
Assessment criteria	
The learner can: 2.1 describe the construction and operation of DC machines.	

Range	
2.1	Shunt, Series, Compound

Learning outcome	The learner will:
3 Be able to select a DC machine for a given purpose	
Assessment criteria	
The learner can: 3.1 calculate DC motor characteristics 3.2 calculate DC generator characteristics.	

Range
3.1 Torque, Back EMF, Speed and power 3.2 Terminal voltage, Load current

Learning outcome	The learner will:
4 Understand the transient behaviour of resistor / capacitor (RC) and resistor inductor (RL) in DC circuits	
Assessment criteria	
The learner can: 4.1 describe the transient behaviour of RC and RL circuits.	

Range
4.1 Growth and decay of voltage and current with time

Learning outcome	The learner will:
5 Understand the effects of power factor, resonance, leading and lagging circuits	
Assessment criteria	
The learner can: 5.1 calculate power factor values and describe effects on equipment selection.	

Range
5.1 Calculate power factor Describe equipment required for power factor correction and calculate power factor correction values to industry standards

Learning outcome	The learner will:
6 Understand single-phase alternating current (AC) theory	
Assessment criteria	
The learner can: 6.1 describe single phase AC circuit theory to determine the characteristics of a sinusoidal AC waveform.	

Range
6.1 Describe how sine waveform is generated and calculate voltage levels

Describe and calculate RMS values Describe and calculate effects on frequency caused by generator rotation speed

Learning outcome	**The learner will:**
7	Be able to use single-phase alternating current (AC) theory in series and parallel circuits
Assessment criteria	
The learner can: 7.1 use single phase AC circuit theory to determine the characteristics of a sinusoidal AC waveform.	

Range
7.1 Use algebraic and phasor theory to add together two sinusoidal waveforms For an AC circuit calculate the current, voltage, impedance, phase angle and power under the application of a sinusoidal waveform Calculate the resonance and Q factor of a LCR circuit

Learning outcome	**The learner will:**
8	Understand the generation and transmission of three phase alternating systems
Assessment criteria	
The learner can: 8.1 describe the generation and transmission of three phase supply systems.	

Range
8.1 Describe generation principles, voltages and phasing Use transformer equations to calculate primary and secondary - voltages, current and winding ratios Calculate transformer efficiency

Learning outcome	**The learner will:**
9	Be able to use three phase alternating current (AC) theory
Assessment criteria	
The learner can: 9.1 calculate power, voltage and current values in three phase systems.	

Range
9.1 Calculate phase voltage, phase current, line voltage, line current, power and power factor correction in three phase star and delta configurations

Learning outcome	The learner will:
10 Understand how a three phase induction motor operates	
Assessment criteria	
The learner can: 10.1 describe the principles of the construction and operation of three phase AC induction motors.	

Learning outcome	The learner will:
11 Know how to select a three phase AC induction motor for a given purpose	
Assessment criteria	
The learner can: 11.1 determine the characteristic of a three phase AC induction motor.	

Unit 406 Mathematics in power engineering

UAN:	**R/503/1031**
Level:	3
Credit value:	12
GLH:	60

Learning outcome	**The learner will:**
1 Transpose engineering formulae	
Assessment criteria	
The learner can: 1.1 evaluate relevant engineering formulae 1.2 transpose relevant engineering formulae using SI symbols and units 1.3 carry out engineering calculations giving the correct answer with the relevant units.	

Learning outcome	**The learner will:**
2 Evaluate numbers raised to a power in the form of xn and x-n	
Assessment criteria	
The learner can: 2.1 analyse and apply positive and negative indices to different number bases 2.2 multiply and divide given problems in the form of xn and x-n 2.3 carry out calculations using preferred standard form having positive and negative indices.	

Learning outcome	The learner will:
3 Analyse straight line graphs	
Assessment criteria	
The learner can: 3.1 identify rectangular and Cartesian axes (abscissa and ordinate), co-ordinate points 3.2 calculate the gradient or slope of the graph using the ratio of change in the value of 'y', to the change of value of 'x' 3.3 apply a range of 'x' values and 'y' values to plot co-ordinates and produce a straight line graph, identifying the 'C' y axis intercept.	

Learning outcome	The learner will:
4 Evaluate linear simultaneous equations	
Assessment criteria	
The learner can: 4.1 solve graphical equations having two unknowns by plotting the interception point 4.2 solve simultaneous equations having two unknowns using the substitution rule 4.3 apply simultaneous equations to solve practical network problems.	

Learning outcome	The learner will:
5 Use quadratic equations to resolve engineering problems	
Assessment criteria	
The learner can: 5.1 analyse the equation in the form, y = ax2+bx+c 5.2 solve a quadratic equation by graphical means to produce a parabola, and identify the turning points (negative and positive) 5.3 determine the roots of a quadratic equation.	

Learning outcome	The learner will:
6 Analyse logarithms and their application in engineering systems	
Assessment criteria	
The learner can: 6.1 evaluate the basis of logarithmic values, e.g., log102 = 0.30103 Anti-log100.30103=2 6.2 express graphs in the form of y = axn in linear form. Comparing to y=mx+C 6.3 analyse the use of log-linear and log-log graph paper.	

Learning outcome	The learner will:
7 Evaluate the properties of a circle	
Assessment criteria	
The learner can: 7.1 state the relationship of the circumference to the diameter expressed as the constant, π 7.2 evaluate the circle in terms of 2 π radians.	

Learning outcome	The learner will:
8 Use trigonometry in engineering applications	
Assessment criteria	
The learner can: 8.1 evaluate the ratios of right angle trigonometry, sine, cosine, tangent 8.2 evaluate trigonometric graphs and the combination of waveforms, y = Sin A and y = Sin 2A 8.3 8.3 periodic functions, e.g. repeated every 360^0 (ω Rads).	

Learning outcome	The learner will:
9 Introduction to complex numbers	
Assessment criteria	
The learner can: 9.1 apply rectangular components in the form $a \pm jb$ 9.2 use Argand diagrams to evaluate three phase phasor values.	

Learning outcome	The learner will:
10 Perform differential coefficient and gradient of a curve (y = f(x)) calculations	
Assessment criteria	
The learner can: 10.1 use integration for simple polynomial functions, exponential functions and sinusoidal functions 10.2 apply integrals, constant of integration and definite integrals.	

Unit 407 Mechanical theory and principles in power engineering

UAN:	**Y/503/1032**
Level:	Level 3
Credit value:	8
GLH:	40
Aim:	This unit will provide the student with the principles of mechanical engineering, thermo dynamic and fluid systems (as applied) in a utilities environment.

Learning outcome	**The learner will:**
1	Be able to determine the effects of loading in static engineering systems in the power engineering industry
Assessment criteria	
The learner can: 1.1 calculate the forces exerted on distribution and transmission support structures 1.2 calculate the reactions of load bearing supports used in the power engineering industry 1.3 calculate direct stress and strain, shear stress and strain and torsional loading for components used in the power engineering industry.	

Learning outcome	**The learner will:**
2	Be able to determine work, power and energy transfer in dynamic engineering systems
Assessment criteria	
The learner can: 2.1 solve power engineering problems that require the application of kinetic and dynamic principles.	

Learning outcome	The learner will:
3 Be able to determine the parameters of fluid systems	
Assessment criteria	
The learner can: 3.1 calculate the forces acting on a submerged plate 3.2 determine the up thrust on an immersed body including Archimedes Principle 3.3 calculate the velocity of an incompressible fluid subjected to different operational conditions.	

Learning outcome	The learner will:
4 Understand the processes of heat transfer	
Assessment criteria	
The learner can: 4.1 describe the processes of fusion and vaporisation 4.2 describe the effects of heat on viscosity.	

Learning outcome	The learner will:
5 Be able to determine the effects of energy transfer in thermodynamic systems	
Assessment criteria	
The learner can: 5.1 calculate the dimensional change when a solid material undergoes a change in temperature 5.2 solve problems that require application of thermodynamic process equations for a perfect gas.	

Learning outcome	The learner will:
6 Design and build a fluid power system	
Assessment criteria	
The learner can: 6.1 illustrate, with the aid of given diagrams, the operation of a fluid power system 6.2 design a fluid circuit that performs a given function	

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**.

Providing City & Guilds qualifications – a guide to centre and qualification approval 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.

Ensuring quality contains updates and good practice exemplars for City & Guilds assessment and policy issues. Specifically, the document contains information on:

- Management systems
- Maintaining records
- Assessment
- Internal verification and quality assurance
- External verification.

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**
  Find out how to register and certificate candidates on line
- **Events**
  Contains dates and information on the latest Centre events
- **Online assessment**
  Contains information on how to register for GOLA assessments.

City & Guilds

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Useful contacts

UK learners **General qualification information**	**T: +44 (0)844 543 0033** **E: learnersupport@cityandguilds.com**
International learners General qualification information	T: +44 (0)844 543 0033 F: +44 (0)20 7294 2413 E: **intcg@cityandguilds.com**
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **centresupport@cityandguilds.com**
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	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 F: +44 (0)20 7294 2404 (BB forms) E: **singlesubjects@cityandguilds.com**
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **intops@cityandguilds.com**
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, GOLA, Navigation, User/menu option, Problems	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413 E: **walledgarden@cityandguilds.com**
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 E: **business_unit@cityandguilds.com**
Publications Logbooks, Centre documents, Forms, Free literature	T: +44 (0)844 543 0000 F: +44 (0)20 7294 2413

If you have a complaint, or any suggestions for improvement about any of the services that we provide, email: feedbackandcomplaints@cityandguilds.com

About City & Guilds

City & Guilds is the UK's leading provider of vocational qualifications, offering over 500 awards across a wide range of industries, and progressing from entry level to the highest levels of professional achievement. With over 8500 centres in 100 countries, City & Guilds is recognised by employers worldwide for providing qualifications that offer proof of the skills they need to get the job done.

City & Guilds Group

The City & Guilds Group includes City & Guilds, ILM (the Institute of Leadership & Management, which provides management qualifications, learning materials and membership services), City & Guilds NPTC (which offers land-based qualifications and membership services), City & Guilds HAB (the Hospitality Awarding Body), and City & Guilds Centre for Skills Development. City & Guilds also manages the Engineering Council Examinations on behalf of the Engineering Council.

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