Unit 39: Electrical Principles in Building Services Engineering

Unit code: A/600/0415

QCF Level 3: BTEC Nationals

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit enables learners to develop a knowledge of the behaviours of electrical components and to develop skills in the application and use of components and equipment to design electrical circuits.

Unit introduction

An understanding of how electricity works is essential to the process of designing, testing and commissioning electrical installations and to understanding how electrical plant, equipment and machinery is used in the building services engineering sector.

The unit should be primarily stand alone as it deals with the fundamental principles of electricity. The purpose of this is to give learners knowledge and understanding of the operation and behaviour of electrical components and circuits. It will also help develop the skills needed to design electrical installations and control systems that meet the requirements of relevant legislation, codes of practice and appropriate guidelines.

In particular, the unit explores the various measurements and quantities associated with electrical energy, and investigates the production and use of direct and alternating values of voltage and current in both static equipment such as transformers and in rotating machines such as motors and generators. The unit also covers the application of Ohm's Law and Kirchoff's Laws and the properties of resistance, impedance and reactance in electrical circuits.

An ability to apply and transpose mathematical formulae would be an advantage for anyone studying this unit.

Learning outcomes

On completion of this unit a learner should:

1 Be able to apply appropriate procedures to determine quantities associated with electricity

2 Be able to use the principles of electricity and the behaviour of simple electrical components for different applications

3 Be able to solve problems relating to the use of single-phase and three-phase AC circuits and produce simple circuit designs to given specifications

4 Be able to apply the principles of transformers and rotating machines to demonstrate their practical applications.

Unit content

1 Be able to apply appropriate procedures to determine quantities associated with electricity

Quantities associated with electricity: units; calculations to determine quantities; instruments used to measure such quantities

Units: basic and derived SI units including multiples and sub-multiples of units and indices; basic electrical quantities of charge, current, voltage, resistance, conductance and resistivity; standard symbols and their abbreviations

Calculations: calculation of electrical power, electrical energy, electrical charge and quantity of energy; Ohm's Law and Kirchoff's Laws for series, parallel and combination circuits; determination of values of resistance, voltage, current and power; use of material resistivity to determine resistance of materials

Instruments: use of electrical measuring instruments eg ammeter, voltmeter, Ohmmeter, Wattmeter, multi-meter, cathode ray oscilloscope (CRO)

2 Be able to use the principles of electricity and the behaviour of simple electrical components for different applications

Terminology: potential difference, electro-motive force (emf) and voltage; direct current (DC) and alternating current (AC); AC waveforms (average, peak-to-peak, root-mean-squared (rms) and frequency values)

Principles and calculations: Faraday's Law; Lenz's Law; calculations to determine magnetic flux, flux density, induced emf; electrostatic field and electric field strength for capacitors; energy stored in inductor; back-emf, self-inductance and mutual-inductance; inductance of a coil

Behaviour: heating effects of current in thermostats and protective devices; electric current – conventional current flow and electron current flow; effects of magnetism in solenoids; electro-magnets

Components: electrical conductors; electrical insulators; cells; generators; resistors; ohmic values using colour, letter and digit codes; capacitors and capacitance; inductors and inductance; diodes; thyristors, transistors and integrated circuits; photocells and photovoltaic devices; thermistors; thermocouples

Applications: use of diodes in half-wave and full-wave rectification circuits; use of thyristors in power control circuits; the use of photocells, thermistors and thermocouples in electrical control circuits; production and transmission of electricity; uses of AC and dc

3 Be able to solve problems relating to the use of single-phase and three-phase ac circuits and produce simple circuit designs to given specifications

Single-phase circuits: effects of pure resistance, pure capacitance and pure inductance in series and parallel circuits including the current and voltage phase relationships and corresponding phasor diagrams; conditions for resonance; effects of frequency on reactance and impedance; effects of resonance; benefits of power factor correction

Three-phase circuits: principles and application of star and delta connected systems including phasor diagrams for balanced and unbalanced loads; advantages of load balancing; relationship to single-phase supplies

Simple circuit designs: calculations to establish values of capacitive reactance, inductive reactance and impedance (including use of impedance triangle in single-phase AC circuits); calculations involving true power, apparent power, reactive power and power factor (including use of power triangle in single- and three-phase AC circuits); relative advantages and disadvantages of three-phase delta and star connected systems; use of three-phase delta and star connected systems

4 Be able to apply the principles of transformers and rotating machines to demonstrate their practical applications

Transformers: operating principles of single-phase transformer; transformer construction; rating of a transformer; equivalent circuit of a transformer; transformer regulation including iron losses, copper losses and eddy-current losses; transformer efficiency; no-load and on-load phasor diagrams; types of transformer including small power, large power, auto, three-phase, current and voltage transformers; transformer cooling methods; calculations to apply transformer formula to specify transformers and determine efficiency

Practical applications of transformers: to step-up and step-down voltage and current; to isolate; to measure currents and voltages

Rotating machines: operating principles of AC induction, wound rotor and synchronous motors; operating principles of DC series and shunt wound motor types; armature reaction; relationship between speed and torque; energy conversion process; construction of machines; function of machines and generators; action of commutator; use of slip-rings and brushes; control systems including starters; typical applications; characteristics, enclosures for motors; inverter control; sizing and selecting motors

Practical applications of rotating machines: selection of motors for particular uses; use of various motor starter and control methods

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 use Ohm's and Kirchoff's Laws to perform calculations on direct current series, parallel and combination circuits [IE1, IE2, IE4, IE6, CT5, RL3, SM2]		
P2 determine the resistance of a length of conductor material [IE1, IE2, IE4, IE6, CT5, RL3, SM2]		
P3 use instruments to measure electrical quantities		
P4 describe the behaviour of components for selected electrical applications [IE1, IE2, IE4, IE6, CT2, CT5, RL3, RL6, SM2, SM3]	**M1** explain the relationship between peak and rms values of voltage and current	
P5 use principles and calculations for electricity and magnetism to solve AC and DC problems [IE1, IE2, IE4, IE6, CT2, CT5, RL3, RL6, SM2, SM3]		

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P6 solve problems on single-phase AC series and parallel circuits containing resistance, inductance and capacitance [IE1, IE2, IE4, IE6, CT5, RL3, SM2]	**M2** produce phasor diagrams for single- and three-phase, balanced and unbalanced, ac circuits	**D1** justify the specification of building services equipment for use in single-phase and three-phase circuits
P7 solve problems on three-phase AC star and delta connected circuits [IE1, IE2, IE4, IE6, CT5, RL3, SM2]		
P8 produce circuit designs to a given specification		
P9 select transformers for given applications using appropriate properties and principles [IE1, IE2, IE4, IE6, CT5, RL3, SM2]	**M3** justify the use of transformers for given applications	**D2** evaluate the types of motors commonly available in the marketplace in terms of their advantages and disadvantages in use.
P10 select rotating machines for given applications using appropriate properties and principles.	**M4** justify the use of rotating machines for given applications.	

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills which are embedded in the assessment of this unit. By achieving the criteria, learners will have demonstrated effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

This unit should be primarily stand alone as it deals with the fundamental principles of electricity. It could also be used as a building block or integrated with other units in building engineering services. Care should be taken to avoid duplication of subject matter and assessment when integrating delivery.

It is important to ensure that learners studying this unit are aware of the planned and progressive structure of the learning outcomes. The emphasis being that before the next step in the learning process can usually be taken, the knowledge from the previous learning outcome is required. However, there may be times when learners may have gained adequate knowledge and experience previously but this should be confirmed through assessment.

Learners should clearly appreciate that each aspect and topic form a stage in the overall process of understanding the principle of how electricity works and its application and relevance to plant, equipment and machinery that is used in both the electrical and building engineering services sector. The unit does not deal with the actual installation of electrical plant and equipment, which is handled elsewhere in other electrical installation specialist units.

The unit should not be seen as an academic exercise. It should, at all times, be based on real-life applications and reflect industry best practice. The method of delivery should, as far as possible, be activity based where learning activities could include laboratory work, case studies, product investigations and completion of basic design proposals and specifications.

The delivery process should balance the calculations implicit within learning outcome 1, the knowledge and skills required in learning outcomes 2 and 3 and the application required in learning outcome 4. It should also, where possible, ensure that appropriate attention is given to health, safety and welfare arrangements.

Learners should be encouraged to refer to documents, such as IEE Regulations, CIBSE Guides, codes of practice, British Standards and Building Regulations, in order to gain knowledge of a wide and confirmed range of advice on best practices for electrical plant, machinery and electrical circuits.

The use of current, up-to-date manufacturers' product information should also be encouraged to help learners apply the principles and procedures that would be used in industry. Emphasis should be on the need for learners to understand how to correctly access and use particular charts and diagrams which help with manual calculations. Industry-standard software may be used to perform certain design functions in the process of assembling a project. It is important that learners are able to challenge any results gained from the software by carrying out either 'rule of thumb' or longhand manual calculations. There is an assumption that learners have appropriate levels of mathematical, science and IT skills to undertake and complete this unit.

Group activities are permissible, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken before practical activities are taken. Centres are advised to read the *Delivery approach* section in the specification, and *Annexe H: Provision and Use of Work Equipment Regulations 1998 (PUWER).*

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction by tutor Whole-class teaching – SI system of base and derived units incorporating use of multiples, sub-multiples, indices, symbols and abbreviations Individual formative exercises – calculations using basic and derived SI units Whole-class teaching – basic electrical quantities of resistance, conductance, current, voltage and charge, properties of conductors and insulators Whole-class teaching – application of Ohm's Law and Kirchoff's Laws to DC series, parallel and combination circuits. Resistivity of materials Individual formative exercises – calculation of resistance, current, voltage and power values using Ohm's Law and Kirchoff's Laws, circuit locations for measuring devices Individual exercise – calculations using material resistivity
Whole-class teaching – magnetism, effects in solenoids, electromagnets and motors, the production of alternating current, Faraday's and Lenz's laws, properties of an AC waveform, chemical, thermal, heating effect of current in thermostats/protective devices Individual exercises – calculations on magnetic flux, flux density and induced emf
Assignment 1: The Basic Principles, Procedures and Applications of Electricity
Whole-class teaching – inductors, self-inductance, mutual-inductance, energy and losses Individual exercises – calculating back-emf values, electrostatics and basic capacitance including capacitors connected in series and parallel
Whole-class teaching – resistor types and usage including colour coding and wattage, capacitor types and usage including colour coding and working voltage, basic operation and use of semi-conductors including diodes, transistors, photocells and integrated circuits. Basic operation and use of thermocouples, thermistors and infrared detectors
Whole-class teaching – effects of resistance, inductance and capacitance in series and parallel single-phase AC circuits, conditions for resonance and its effect on circuit current, effects of frequency change on AC circuit reactance, determination of true, reactive and apparent power, power factor in circuits, phasor diagrams, power and impedance triangles Individual exercises – calculations involving resistance, inductance, capacitance, power and power factor in single-phase AC circuits
Whole-class teaching – principles and application of star and delta connected three-phase systems, balanced and unbalanced loads, advantages of load balancing demonstrated by the use of phasor diagrams, relationship between three-phase and single-phase supplies Individual exercises – calculations involving three-phase star and delta supplies

Topic and suggested assignments/activities and/assessment
Assignment 2: Single-Phase and Three-Phase Circuits
Whole-class teaching – operating principles of a single-phase transformer for step-up, step-down and isolating purposes, transformer losses including iron losses, copper losses and eddy-current losses, transformer construction, rating and methods of cooling, types of transformer and their applications including dangers associated with current transformers Phasor diagrams, three-phase transformers, use in power transmission and distribution Individual exercises – calculations involving single-phase transformers
Whole-class teaching – DC motors and generators, commutation, construction, types and use of DC motors including enclosure, cooling methods and rating, operating principles of single-phase and three-phase AC motors and generators, use of slip-rings and brushgear, construction, types and use of AC motors including enclosure, cooling methods and rating, control systems including starters, inverters, safety circuits, sizing and selecting motors Individual exercises – calculations for speed, frequency and slip of AC induction motors
Assignment 3: Transformers and Rotating Machines
Review of unit and assignment feedback

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments. There are many suitable forms of assessment that could be used, and tutors are encouraged to consider and adopt these where appropriate. Some example assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used then suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

This unit allows for flexibility in the types of assessment methods that can be used throughout. Some criteria are best suited to well-planned laboratory work, others to assignments that involve calculations, diagrams and text, or to simple design activities involving selection and specification processes. Few criteria will suit all three assessment methods but some may allow for two.

The fundamental principles of electrical operations are often best demonstrated when learners are able to see for themselves the effects and results. Experiments in a laboratory, showing different processes and uses of equipment, could be carried out by learners, with evidence for assessment presented as a combination of a visual record by the tutor and the preparation and maintenance of suitable learner logbooks or part of a training manual. Learners could also provide work-based evidence for assessment, provided that this evidence is appropriate and authenticated as the learner's own work.

The structure of the unit suggests that the grading criteria could be addressed fully by using three assignments. The first of these would cover P1, P2, P3, P4, P5 and M1, the second would cover P6, P7, P8, M2 and D1 and the third P9, P10, P11, M3, M4 and D2.

To achieve a pass grade learners must meet the 10 pass criteria listed in the grading criteria grid.

For P1, learners must use Ohm's Law and Kirchoff's Laws to perform calculations on direct current, series, parallel and combination circuits. They are expected to formulate answers to simple problems involving total resistance, voltage, current, charge, energy, power or any combination of these.

For P2, learners must determine the resistance of a length of conductor material from the resistivity, cross-sectional area and length of the conductor. Learners should recognise that temperature affects resistance but do not need to allow for this in their calculations.

For P3, learners must select and use appropriate instruments to measure voltage and current in DC circuits. They should differentiate between the portable instruments used for testing and certificating and those instruments that may be fixed into an installation for permanent measuring/monitoring/recording of the system. Learners will need to explain the reason why each instrument was selected.

For P4, learners must describe the behaviour of components for selected electrical applications. The evidence should include the effects of magnetism in solenoids, Faraday's and Lenz's Laws.

For P5, learners must use principles and calculations for electricity and magnetism to solve AC and DC problems. Evidence should include electromagnetic induction and the production and transmission of electricity, the effects of magnetism in solenoids, and the principles and uses of electromagnetism. Faraday's and Lenz's Laws should feature in learner responses. Correct terminology should be used throughout.

For P6, learners must solve problems on single-phase AC series and parallel circuits. They should demonstrate an understanding of the difference in characteristics of the two types of circuits, and why and where they are used in the building engineering services sector. Correct terminology should be used throughout. Learners are also expected to determine parameters such as conditions of resonance, selectivity, Q factor, impedance, reactance and power factor.

For P7, learners must solve problems on three-phase AC star and delta connected circuits. A similar range of parameters as for P6 should be determined.

For P8, learners must produce circuit designs to a given specification provided by the tutor.

For P9, learners must select transformers for given applications using appropriate properties and principles. Applications should involve step-up, step-down, isolation and measurement functions. In each case, use must be set in a practical context and it should be clear what is being achieved. Learners should state reasons for their choice of transformer.

For P10, learners must select rotating machines for given applications using appropriate properties and principles. Learners should state reasons for their choice of rotating machine.

To achieve a merit grade learners must meet all of the pass grade criteria and the four merit grade criteria.

For M1, learners must explain the relationship between rms values and peak values and must support this with appropriate calculations.

For M2, learners must produce phasor diagrams for both single-phase and three-phase, balanced and unbalanced, AC circuits. They should describe the role and different characteristics of each.

For M3 and M4, learners must make valid and appropriate justifications for the use of transformers and motors in building engineering services applications. Learners should describe, with the aid of sketches and schematic drawings, where and how this equipment can/or should be suitably applied.

Learners should show that the information they have gathered is current and determine the advantages of the equipment over previous technologies.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria and the two distinction grade criteria.

For D1, learners must justify the selection of building services plant and equipment in regard to single- and three-phase requirements, and explain why using examples. They should show their understanding of the different type of plant and equipment that demand the alternative electrical connections and the significant implications that a wrong specification can have on a project. Learners are expected to justify their explanations by citing examples of problems that may/could have occurred in practice and how these could be resolved.

For D2, learners must evaluate the types of motors commonly available in the marketplace and used in building services applications, and compare their advantages and disadvantages in use. They should prepare a manual or report on the products to include the use of photographs, diagrams and sketches. Learners are required to use their analytical skills to compare the advantages and disadvantages of the selected motors and their judgemental skills to explain all the implications of using the correct and incorrect machines in particular applications.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, P4, P5, M1	The Basic Principles, Procedures and Applications of Electricity	As a building services engineer, you have been asked to provide a training manual to be used by trainee building services engineers. This comes in four parts and should be used to links the principles and practical applications of electricity. Exemplar calculations should be included throughout.	Manual, report and/or presentation to include text, images, calculations, graphs, tables and charts as appropriate.
P6, P7, P8, M2, D1	Single-Phase and Three-Phase Circuits	As above but extended to single- and three-phase circuits.	Manual, report and/or presentation to include text, images, calculations, graphs, tables and charts as appropriate.
P9, P10, P11, M3, M4, D2	Transformers and Rotating Machines	As above but extended to transformers and rotating machines.	Manual, report and/or presentation to include text, images, calculations, graphs, tables and charts as appropriate.

Links to other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Construction and the Built Environment sector suite. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
		Building Services Control Systems
		Electrical Installation Standards and Components in Building Services Engineering
		Electrical Installation Design in Building Services Engineering
		Commissioning Electrical Installations in Building Services Engineering

Essential resources

Centres should have access to a wide range of hard copy or online technical and manufacturers' literature, some of which are listed below. The availability of visual aids, such as the range of basic electrical components indicated for learning outcomes 2 and 4, would be advantageous. These can be in the form of models and/or as part of live installations. Centres should have access to sets of electrical schematic drawings to support the learning process and facilitate assessments. Where these drawings are used as part of the assessment process it is recommended that repeated use of the same type is avoided to maintain the freshness of the assessment process.

Learners should have access to laboratories that allow the application of electrical principles to be put into practice. Learners could witness this or take part in experiments to see how electrical terminology is expressed in real terms, to solve given problems and produce basic designs of simple circuits to operate small pieces of plant and equipment.

Employer engagement and vocational contexts

Support to enable centres to initiate and establish links to industry, and to networks arranging visits to industry and from property practitioners is given below:

- Learning and Skills Network – www.vocationallearning.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI University of Warwick) – www.warwick.ac.uk/wie/cei/

Indicative reading for learners

Textbooks

Bird J – *Electrical and Electronic Principles and Technology, 2nd Edition* (Newnes, 2004) ISBN 0750665505

Hiley J, Brown K and Smith I – *Electrical and Electronic Technology, 9th Edition* (Prentice Hall, 2004) ISBN 0131143972

Robertson C – *Fundamental Electrical and Electronic Principles, 2nd Edition* (Elsevier, 2001) ISBN 0750651458

Journals

Electrical and Mechanical Contractor – Electrical Contractors' Association

Professional Electrician and Installer – Hamerville Magazines Ltd

Websites

www.elecsa.org.uk	Electrical Contractors' Association
www.enginuity.org.uk	Engineering resources
www.jib.org.uk	Joint Industry Board for the Electrical Contracting Industry
www.jtltraining.com	Training in the electrical sector
www.scenta.co.uk	Engineering and technology careers and news
www.sectt.org.uk	Scottish Electrical Charitable Training Trust
www.semta.org.uk	Sector Skills Council for Science, Engineering and Manufacturing Technologies
www.summitskills.org.uk	Sector Skills Council for the Building Services Engineering Sector

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	identifying questions to answer and problems to resolve, planning and carrying out research, appreciating the consequences of decisions, analysing and evaluating information, judging its relevance and value and supporting conclusions, using reasoned arguments and evidence, as they: • use Ohm's and Kirchoff's Laws to perform calculations on direct current series, parallel and combination circuits • determine the resistance of a length of conductor material • describe the effects of magnetism in electrical circuits • identify methods of producing DC and AC currents • identify the components of an AC waveform • perform calculations on single-phase AC series and parallel circuits containing resistance, inductance and capacitance • perform calculations on three-phase AC star and delta connected circuits • justify the uses of transformers and rotating machines for given applications
Creative thinkers	asking questions to extend their thinking and trying out alternatives or new solutions and following ideas through, as they: • use Ohm's and Kirchoff's Laws to perform calculations on direct current series, parallel and combination circuits • determine the resistance of a length of conductor material • describe the effects of magnetism in electrical circuits • identify methods of producing DC and AC currents • identify the components of an AC waveform • perform calculations on single-phase AC series and parallel circuits containing resistance, inductance and capacitance • perform calculations on three-phase AC star and delta connected circuits • justify the uses of transformers and rotating machines for given applications

Skill	When learners are ...
Reflective learners	reviewing progress, acting on the outcomes and communicating their learning in relevant ways for different audiences, as they: • use Ohm's and Kirchoff's Laws to perform calculations on direct current series, parallel and combination circuits • determine the resistance of a length of conductor material • describe the effects of magnetism in electrical circuits • identify methods of producing DC and AC currents • identify the components of an AC waveform • demonstrate the effects of system frequency on reactance and impedance values • perform calculations on single-phase AC series and parallel circuits containing resistance, inductance and capacitance • perform calculations on three-phase AC star and delta connected circuits • justify the uses of transformers and rotating machines for given applications
Self-managers	working towards goals, showing initiative, commitment and perseverance, organising time and resources and prioritising actions, as they: • use Ohm's and Kirchoff's Laws to perform calculations on direct current series, parallel and combination circuits • determine the resistance of a length of conductor material • describe the effects of magnetism in electrical circuits • identify methods of producing DC and AC currents • identify the components of an AC waveform • perform calculations on single-phase AC series and parallel circuits containing resistance, inductance and capacitance • perform calculations on three-phase AC star and delta connected circuits • justify the uses of transformers and rotating machines for given applications.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using the internet to research principles of electricity saving material electronically using email to communicate with the tutor and other learners
Manage information storage to enable efficient retrieval	downloading and saving internet files and their own work electronically
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using the internet to research principles of electricity saving material electronically using email to communicate with the tutor and other learners
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including:	producing reports, manuals and/or presentations for both formative and summative assessment purposes
Present information in ways that are fit for purpose and audience	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	using email to communicate with the tutor and other learners
Mathematics	
Identify the situation or problem and the mathematical methods needed to tackle it	performing calculations relating to the principles of electricity
Select and apply a range of skills to find solutions	
Draw conclusions and provide mathematical justifications	
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching electrical principles and practices from books, journals, CD ROMs and websites
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	producing reports for assessment purposes.