Unit 72: Electrical Principles in Building Services Engineering

Unit code: A/600/0415

QCF Level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

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

Learning outcomes and assessment 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 determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1 Be able to apply appropriate procedures to determine quantities associated with electricity	1.1 use Ohm's and Kirchoff's Laws to perform calculations on direct current series, parallel and combination circuits
	1.2 determine the resistance of a length of conductor material
	1.3 use instruments to measure electrical quantities
2 Be able to use the principles of electricity and the behaviour of simple electrical components for different applications	2.1 describe the behaviour of components for selected electrical applications
	2.2 use principles and calculations for electricity and magnetism to solve ac and dc problems
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	3.1 solve problems on single-phase ac series and parallel circuits containing resistance, inductance and capacitance
	3.2 Produce material specifications for highway pavement construction

	3.1 produce circuit designs to a given specification
4 Be able to apply the principles of transformers and rotating machines to demonstrate their practical applications	4.1 select transformers for given applications using appropriate properties and principles
	4.2 select rotating machines for given applications using appropriate properties and principles

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