# Learning Outcomes for Electrical Maintenance Training Online

The following pages detail the Learning Outcomes delivered on the course :-

## Electrical Maintenance Training Online

This is a very popular course of theory and practice and is suitable for a range of people needing electrical skills for electrical maintenance and servicing work.
The course benefits from having External Verification and Certification by an external body.

You will retain your course portfolio with its marked assessments and completed tasks providing evidence of your achievement, valuable to your employer.

**Unit 1 Legislation governing the use of electricity.**

**Unit 2 Current Flow**

**Unit 3 The electrical circuit and Ohms Law**

**Unit 4 Testing cables for continuity and insulation resistance**

**Unit 5 Industrial Power Supply Voltages**

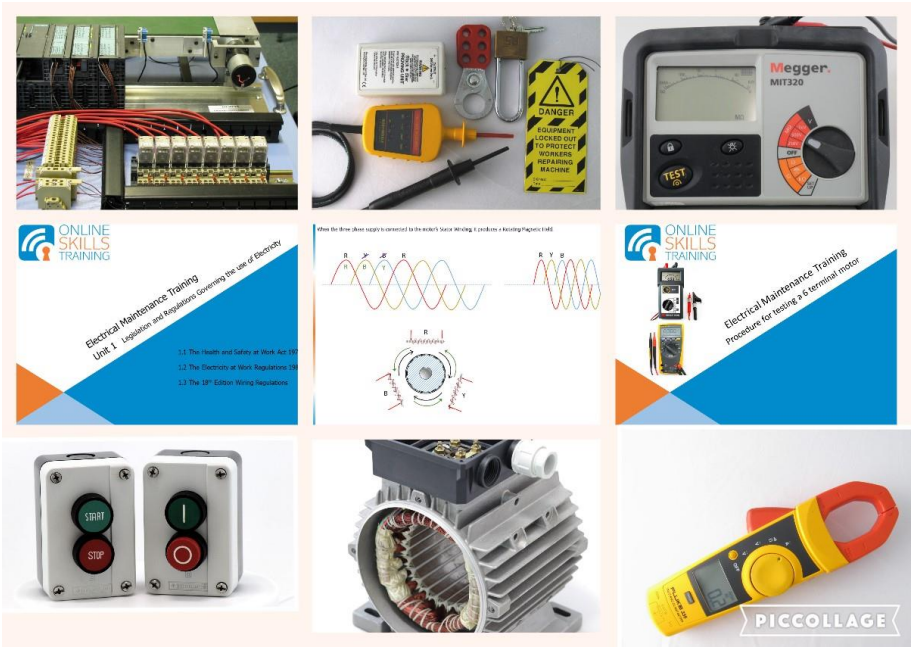
**Unit 6 Motors….. Construction and Operation**

**Unit 7 Electrical Hazards**

**Unit 8 Isolation and Switching**

**Unit 9 Devices for circuit protection**

**Unit 10 Motor Control Circuits**

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**Learning Outcomes from each of the 10 Units of Electrical Maintenance Training Part 1**

Prior to beginning the units, there is a short section on using "Engineering Standard Form". This is a review for most people on numerical terminology and following this section the delegate will be able to use and manipulate electrical quantities of Ohms, Volts, Amps Farads etc and deliver them into Standard Form in terms of milli, micro, nano, pico, Kilo, Mega, Giga, Tera.

## Unit 1 Legislation governing the use of electricity.

The delegate can define and compare statutory and non-statutory regulations including Electricity at Work Regs and 18th Ed Wiring Regs.
Delegate can describe the role of each document and how each one relates to the work areas of electrical maintenance work and electrical installations.

## Unit 2 Current Flow

The delegate can describe current flow as a drift of electrons and define a conductor from a knowledge of the electron behaviour of common conducting metals. The delegate can also define an insulating material from a knowledge of its electron behaviour, particularly its lack of free electrons.

The delegate can define the direction of current flow in a circuit and compare the terms Electron Current Flow and Conventional Current Flow
The delegate can determine the magnitude of current flowing in a circuit in terms of Coulombs per Second.
The delegate can describe the correct method of connecting an ammeter into the circuit to measure the value of current flowing in the circuit and state that it is connected in series with the load.

The delegate can define and compare electromotive force and potential difference and can select the correct instrument, setting and procedure to test for voltages in a circuit and state that it is connected in parallel with the load.

The delegate can define Resistance as an opposition to current flow.

The delegate can list a range of common conductors and insulators.

The delegate can list the factors affecting resistance including resistivity and state a formula linking these factors to calculate the resistance of a wire of given length and CSA. The delegate can define the OHM by drawing a circuit diagram of 1volt causing 1amp to flow in the circuit.

The delegate can describe how to safely select, set scale and use an ohmmeter to read resistance.

## Unit 3 The Electrical Circuit and Ohms Law

The delegate can compare the terms closed circuit and open circuit

The delegate can describe the effects on current flow of introducing a resistance into a closed circuit and recognise the relationship between current, voltage and resistance and illustrate this relationship with the Ohms Law Triangle.

The delegate can list circuit resistive components and describe how resistance may be introduced into a circuit or accidentally removed from a circuit by means of a short and can explain safety implications relating to excessive current flow.

The delegate can calculate current flow, voltage and resistance in simple set questions of resistors connected in series and parallel.

The delegate can draw a circuit with multiple loads connected in parallel and calculate the current through each load and also determine the loading at each point in the circuit as current values combine returning to the source. The delegate can determine the correct fuse or circuit breaker rating for each leg of the circuit and determine the appropriate wiring CSA to match the protective device used.
The delegate can select the correct Power formula and perform power calculations on simple circuits.

## The Multimeter

This is a primer on Multimeter settings.
The delegate can describe the use of each dial setting on a typical common multimeter and can draw waveforms of the voltages likely to be encountered
The delegate can draw the positions of meter leads to test across a diode on the diode test setting and state the polarity used and expected reading for a healthy silicon diode. The delegate can set the multimeter to test current and recognise dangers in testing live and also testing adjacent to charged devices eg capacitors.

## Unit 4 Testing cables for continuity and insulation resistance.

The delegate can identify a variety of cable types including YY, CY, SY, SWA

The delegate determines the 3 tests to be carried out on a cable, ie Visual, Continuity, Insulation Resistance.
The delegate can detail the reasons for each type of cable test and can specify the correct instrument and setting for continuity testing and for insulation testing. The delegate can list a range of factors which can affect the insulation resistance of materials and discuss why regular monitoring of the cables' insulation resistance is important to reduce the risk of electric shock and fire.

The delegate can suggest expected measured resistance values for each test for a healthy cable and state measured values which would conclude the cable to be a fail based on values given in BS7671 and IEE Guidance Note 3.

## Unit 5 Industrial Power Supply Voltages

The delegate can state the requirements and formula for creating an alternating waveform in terms of magnetic field, coils of wire, velocity of rotation and rotating apparatus and draw a 1phase diagram and then a 3phase diagram of the waveforms produced over 360° of rotation.
The delegate can state the angle between phases and can compare the original British 3phase conductor colour sequence with the more recent Euro colours.

The delegate can define characteristics of the ac waveform in terms of Frequency, Peak value, Rms value and relate these to practical field measurements using the multimeter and subsequent Ohms law and power calculations.

The delegate can draw diagrams of first the positive and then the negative half cycles of an ac waveform and its effect on current and flux produced when applied to the primary winding of a transformer, in addition, can show the resultant effects within the secondary winding and the voltage produced if the transformer has a 1:1 turns ratio.

The delegate can calculate the secondary voltage of a transformer from given primary voltage and turns ratio data and can explain the need for a laminated transformer core,.

The delegate can identify and compare Delta and Star 3phase transformer configurations and recognise the connections made at a 3phase step down Delta/Star transformer similar to a switchroom factory distribution transformer.

The delegate can describe the need to transmit high power from the power station at High Voltage 400kv and can state the range of voltages produced by power equipment on the route from power station to factory substation.

The delegate can state the arithmetic relationship between line and phase voltages and give voltage values for both line and phase connections.

The delegate can identify the sections of distribution equipment from 11Kv switchroom transformer to give 3phase and 1phase local supplies in the factory and can specify 4wire, 3wire, 1phase, 1phase 400v connections for a given installation requirement in the factory.

The delegate can describe common control voltages used on plant and machinery and can describe the voltage regulating system used within the switch mode power supply.

## Unit 6 Motors….. Construction and Operation

The delegate can detail the components of a 3phase squirrel cage motor and describe the role of each part including the inductive operation of the rotor and its magnetic interaction with the rotating stator flux.

The delegate can draw a diagram depicting rotor and 3phase windings and demonstrate direction of rotation. The delegate can use this drawing to demonstrate the effects of changing over two of the three phases on the direction of the motor.

The delegate can calculate synchronous speed for 2,4,6,8 pole motors for a given frequency applied and verify the shaft speed of a motor from given rating plate data.

The delegate can describe the Direct on Line motor starter in terms of its internal components, its contactor and overload relay and can discuss the result of incorrect sizing of the motor for the task required. The delegate can draw a graph of starting current against time for the DOL starter.

From a given rating plate, the delegate can determine; configuration of connection for motor windings, (Star or Delta), voltage to be applied, full load current, rating of motor insulation, output power, ingress protection of motor, shaft height and speed. The delegate can describe motor losses.

The delegate can identify and draw the star and delta link connections of a 6 terminal motor from first principles.

The delegate can discuss the basic features of the motor Inverter and the types of motor applicable for operation.

The delegate can detail by drawing, the input and output voltages of two variations of Inverter and for each variation state the motor winding configuration for correct operation …. Star or Delta.

## Unit 7 Electrical Hazards

The delegate can define conditions for *Contact With Live Parts Under Fault-Free Conditions* and for *Electric Shock Under Single Fault Conditions* and can draw the path of shock current flow through the victim and back to the transformer for each of the above situations.

The delegate can determine the following methods of protection against electric shock; Protective Earthing … ADS, Double or Reinforced insulation, Electrical Separation, Separated extra low voltage.

The delegate can recognise that earthing metal parts provides a low impedance path for any fault current causing a high current to flow and blow the fuse or trip the circuit breaker.

The delegate can calculate fault cut-off times for a given fuse and given fault current using tables from the 18th Edition Wiring Regulations

The delegate can describe the electric shock current path through a person to earth, detailing each item in the path to earth as low or high Impedance.

The delegate can explain around various dangerous situations including the following; broken protective earthing conductor within apparatus, lethal potentials, burns, arcing, explosion, fires.

## Unit 8 Isolation and Switching

The delegate can define and compare Functional Switching, Emergency Switching, Switching off for Mechanical Maintenance, Isolation and Testing for Dead; and explain work situations where each of these types of switching would be applicable.

The delegate can describe the features of test equipment required to *Test for Dead* in accordance with GS38 and can identify GS38 approved apparatus and practice.

The delegate can list the test sequence to perform an Isolation Procedure for an uncomplicated 3ph+N+E cubicle arrangement and include within the procedure, steps taken to *Test For Dead* in accordance with GS38.

## Unit 9 Devices for circuit protection

The delegate can define Overcurrent in terms of overload and short circuit conditions and describe the circuit or machinery situations which may cause them.

The delegate can identify a range of circuit protective devices including; rewireable fuse, cartridge fuse, HBC fuse, miniature circuit breaker, motor overload, motor protection circuit breaker, RCD and detail each device in terms of its physical and electrical characteristics, its setting value where appropriate and its breaking capacity.

The delegate can describe the role of the internal components and the operation of each of the above protective devices and can state whether it would be used as protection against sustained overload or short circuit or both of these conditions.

The delegate can describe the purpose of the RCD and where it is required to be installed.

The delegate can draw a diagram depicting the rcd in operation and describe in detail the function and electro-magnetic operation of its internal components.
The delegate can specifically describe the currents passing through the sensing coil both with no current leakage to earth and *with* a small current leaking to earth and describe the resulting magnetic effects within the device and the tripping action.

## Basic Control Circuits and Logic

This is a primer for *Unit 10 Motor Control Circuits.*
The delegate can detail Contol Circuit Inputs and Outputs in terms of their function and their physical and electrical properties. Where appropriate the delegate can state the terminal numbers of a device and state whether it is fitted with Normally Open or Normally Closed contacts.
The delegate can state the contact arrangement for a range of switching devices eg DPDT, SPDT
The delegate can study a circuit diagram employing Input and Output devices and describe the effects on the circuit switching states as various switches are manually activated.
The delegate can incorporate normally open and normally closed switches into a drawing to create a logic AND gate.
The delegate can describe the operation of this system in the form of a truth table using binary values.

The delegate can incorporate normally open and normally closed switches into a drawing to create a logic OR gate.
The delegate can describe the operation of this system in the form of a truth table using binary values.

The delegate can describe the operation of a Start/Stop latching circuit used with first a relay and then with a contactor and draw the incorporation of a relay hold-on contact so that the circuit will Latch on operation of the start button and unlatch on operation of the stop button.

## Unit 10 Motor Control Circuits

The delegate can interpret simple control and 3phase power circuits using the IEC symbol set including the following circuits, Contactor Jog, Contactor Start/Stop latch, Contactor Start/Stop latch with remote Start/Stop station, all with overload trip contacts.

The delegate can interpret a range of IEC Electrical Symbols.

The delegate can compare Power Contacts and Auxiliary Contacts in terms of power rating and practical usage.

The delegate can list the range of common contactor coil voltages and describe its purpose.

The delegate can recognise the IEC layout to simplify 3phase contactor diagrams.

The delegate can describe the operation and state the terminal numbers used to create the circuit for a simple Contactor JOG circuit.
The delegate can describe the operation and state the terminal numbers used to create the circuit for Stop/Start circuit with latch.

The delegate can describe the operation and state the terminal numbers used to create the circuit for Stop/Start circuit with latch and fitted with a remote Start/Stop station.

## EAL Certification

If you wish to gain EAL certification you will need to complete the Online Electrical Maintenance Course and pass all of the Unit tests.
In addition you would attend a one day Assessment session at our Training Venue in Lancashire and carry out the four practical Assessments listed below.

These are the practical Assessments which must be completed during a one day visit to our Training Venue

***Assessment 1 Testing cables for continuity and insulation resistance faults.***
This uses a prepared rig consisting of a multicore armoured cable and a bank of switches used to switch a succession of faults onto the cable. The delegate can describe the features of the cable used.
The delegate can select appropriate instrumentation (Multimeter and Megger Insulation Tester) and set each instrument to an appropriate scale for correctly testing this cable. The delegate can carry out the tests to locate each fault and then write a description of each fault using correct terminology.

***Assessment 2 Isolation and Testing for Dead Procedure***
The delegate can carry out a full Isolation and Testing procedure to GS38 on a 3phase motor and motor starter, selecting and using the appropriate test apparatus and procedure including *Test for Dead*.


***Assessment 3 Testing motors for winding continuity and insulation faults.***

This uses a prepared rig consisting of a 3phase squirrel cage motor and a bank of switches used to switch a succession of faults onto the motor.

The delegate can select appropriate instrumentation (Multimeter and Megger Insulation Tester) and set each instrument to an appropriate scale for correctly testing this motor. The delegate can create a list of operations required to correctly test the motor. The delegate can give expected measured values for each test for a *healthy* motor and state measured values which would conclude the motor to be a *fail* based on values given in BS7671 and Guidance Note 3. The delegate can carry out the testing procedures and use correct terminology to describe the results of each test.

***Assessment 4 Create a Motor Stop/Start latching circuit with remote Start/Stop latch.***

The delegate can draw the control circuit for the Stop/Start latching circuit with remote Stop/Start, connect to the correct power supply and can wire up the circuit on a prepared test rig and then test for correct operation of the circuit.