

Module 3. Electrical Fundamentals

	Level			
	A	B1	B2	B3
3.1 Electron Theory Structure and distribution of electrical charges within: atoms, molecules, ions, compounds; Molecular structure of conductors, semiconductors and insulators.	1	1	1	1
3.2 Static Electricity and Conduction Static electricity and distribution of electrostatic charges; Electrostatic laws of attraction and repulsion; Units of charge, Coulomb's Law; Conduction of electricity in solids, liquids, gases and a vacuum.	1	2	2	1
3.3 Electrical Terminology The following terms, their units and factors affecting them: potential difference, electromotive force, voltage, current, resistance, conductance, charge, conventional current flow, electron flow.	1	2	2	1
3.4 Generation of Electricity Production of electricity by the following methods: light, heat, friction, pressure, chemical action, magnetism and motion.	1	1	1	1
3.5 DC Sources of Electricity Construction and basic chemical action of: primary cells, secondary cells, lead acid cells, nickel cadmium cells, other alkaline cells; Cells connected in series and parallel; Internal resistance and its effect on a battery; Construction, materials and operation of thermocouples; Operation of photo-cells.	1	2	2	2
3.6 DC Circuits Ohms Law, Kirchoff's Voltage and Current Laws; Calculations using the above laws to find resistance, voltage and current; Significance of the internal resistance of a supply.	-	2	2	1
3.7 Resistance/Resistor (a) Resistance and affecting factors; Specific resistance; Resistor colour code, values and tolerances, preferred values, wattage ratings;	-	2	2	1

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Resistors in series and parallel; Calculation of total resistance using series, parallel and series parallel combinations; Operation and use of potentiometers and rheostats; Operation of Wheatstone Bridge;				
(b) Positive and negative temperature coefficient conductance; Fixed resistors, stability, tolerance and limitations, methods of construction; Variable resistors, thermistors, voltage dependent resistors; Construction of potentiometers and rheostats; Construction of Wheatstone Bridge.	-	1	1	-
3.8 Power Power, work and energy (kinetic and potential); Dissipation of power by a resistor; Power formula; Calculations involving power, work and energy.	-	2	2	1
3.9 Capacitance/Capacitor Operation and function of a capacitor; Factors affecting capacitance area of plates, distance between plates, number of plates, dielectric and dielectric constant, working voltage, voltage rating; Capacitor types, construction and function; Capacitor colour coding; Calculations of capacitance and voltage in series and parallel circuits; Exponential charge and discharge of a capacitor, time constants; Testing of capacitors.	-	2	2	1
3.10 Magnetism (a) Theory of magnetism; Properties of a magnet; Action of a magnet suspended in the Earth's magnetic field; Magnetisation and demagnetisation; Magnetic shielding; Various types of magnetic material; Electromagnets construction and principles of operation; Hand clasp rules to determine: magnetic field around current carrying conductor;	-	2	2	1

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<p>(b) Magnetomotive force, field strength, magnetic flux density, permeability, hysteresis loop, retentivity, coercive force reluctance, saturation point, eddy currents;</p> <p>Precautions for care and storage of magnets.</p>	-	2	2	1
<p>3.11 Inductance/Inductor</p> <p>Faraday's Law;</p> <p>Action of inducing a voltage in a conductor moving in a magnetic field;</p> <p>Induction principles;</p> <p>Effects of the following on the magnitude of an induced voltage: magnetic field strength, rate of change of flux, number of conductor turns;</p> <p>Mutual induction;</p> <p>The effect the rate of change of primary current and mutual inductance has on induced voltage;</p> <p>Factors affecting mutual inductance: number of turns in coil, physical size of coil, permeability of coil, position of coils with respect to each other;</p> <p>Lenz's Law and polarity determining rules;</p> <p>Back emf, self induction;</p> <p>Saturation point;</p> <p>Principle uses of inductors.</p>	-	2	2	1
<p>3.12 DC Motor/Generator Theory</p> <p>Basic motor and generator theory;</p> <p>Construction and purpose of components in DC generator;</p> <p>Operation of, and factors affecting output and direction of current flow in DC generators;</p> <p>Operation of, and factors affecting output power, torque, speed and direction of rotation of DC motors;</p> <p>Series wound, shunt wound and compound motors;</p> <p>Starter Generator construction.</p>	-	2	2	1
<p>3.13 AC Theory</p> <p>Sinusoidal waveform: phase, period, frequency, cycle;</p> <p>Instantaneous, average, root mean square, peak, peak to peak current values and calculations of these values, in relation to voltage, current and power;</p> <p>Triangular/Square waves;</p> <p>Single/3 phase principles.</p>	1	2	2	1
<p>3.14 Resistive (R), Capacitive (C) and Inductive (L) Circuits</p> <p>Phase relationship of voltage and current in L, C and R circuits, parallel, series</p>	-	2	2	1

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<p>and series parallel;</p> <p>Power dissipation in L, C and R circuits;</p> <p>Impedance, phase angle, power factor and current calculations;</p> <p>True power, apparent power and reactive power calculations.</p>				
<p>3.15 Transformers</p> <p>Transformer construction principles and operation;</p> <p>Transformer losses and methods for overcoming them;</p> <p>Transformer action under load and no-load conditions;</p> <p>Power transfer, efficiency, polarity markings;</p> <p>Calculation of line and phase voltages and currents;</p> <p>Calculation of power in a three phase system;</p> <p>Primary and Secondary current, voltage, turns ratio, power, efficiency;</p> <p>Auto transformers.</p>	-	2	2	1
<p>3.16 Filters</p> <p>Operation, application and uses of the following filters: low pass, high pass, band pass, band stop.</p>	-	1	1	-
<p>3.17 AC Generators</p> <p>Rotation of loop in a magnetic field and waveform produced;</p> <p>Operation and construction of revolving armature and revolving field type AC generators;</p> <p>Single phase, two phase and three phase alternators;</p> <p>Three phase star and delta connections advantages and uses;</p> <p>Permanent Magnet Generators.</p>	-	2	2	1
<p>3.18 AC Motors</p> <p>Construction, principles of operation and characteristics of: AC synchronous and induction motors both single and polyphase;</p> <p>Methods of speed control and direction of rotation;</p> <p>Methods of producing a rotating field: capacitor, inductor, shaded or split pole.</p>	-	2	2	1