REQUIRED SKILLS AND KNOWLEDGE – UEENEEE104A		
KS01-EE104A Direct current circuits		
Topic and Description	**NIDA Lesson**	**CARD #**
T1 Basic electrical concepts encompassing: • electrotechnology industry • static and current electricity • production of electricity by renewable and non renewable energy sources • transportation of electricity from the source to the load via the transmission and distribution systems • utilisation of electricity by the various loads • basic calculations involving quantity of electricity, velocity and speed with relationship to the generation and transportation of electricity.	5021-114-130 Magnetism, Relays, and Meters ▪ Define magnetism. ▪ Identify characteristics of magnets. ▪ Define laws of magnetic attraction and repulsion. ▪ Describe properties of magnetic lines of force. ▪ Identify non-magnetic materials. ▪ Define electromagnetism. ▪ Identify the characteristics of electromagnetism. ▪ Describe the operation of a relay. ▪ Describe the operation of a magnetic circuit breaker. ▪ Describe the operation of a meter. 5021-114-160 Introduction to Multimeters ▪ Identify the quantities measured by multimeters. ▪ Identify multimeter characteristics. ▪ Describe the functional sections of a digital multimeter. ▪ Describe the purpose of each functional section. 5021-114-190 Multimeter Use ▪ Understand how to operate a digital multimeter. ▪ Operate a digital multimeter. 5021-114-220 Voltage Measurements ▪ Describe how to set up a digital multimeter to measure voltage. ▪ Understand how to read a digital multimeter's display when measuring voltage. ▪ Describe the correct way to connect a multimeter to a circuit for measuring voltage. ▪ Perform voltage measurements with a digital multimeter. 5021-114-250 Current Measurements ▪ Describe how to set up a digital multimeter to measure current. ▪ Describe how to read a digital multimeter's display when measuring current. Describe the correct way to connect a multimeter to a circuit for measuring current.	CF 2 4A

	▪ Identify the precautions to observe when making current measurements. ▪ Perform current measurements with a digital multimeter. 5021-114-280 Resistance Measurements ▪ Describe how to set up a digital multimeter to measure resistance. ▪ Understand how to read a digital multimeter's display when measuring resistance. ▪ Describe the correct way to connect a multimeter to a circuit for measuring resistance. ▪ Identify the precautions to observe when making resistance measurements. ▪ Perform resistance measurements with a digital multimeter. 5021-114-910 Multimeter Use Post-Test (Theory)	4A

T2 Basic electrical circuit encompassing: • symbols used to represent an electrical energy source, a load, a switch and a circuit protection device in a circuit diagram • purpose of each component in the circuit • effects of an open-circuit, a closed-circuit and a short-circuit • multiple and sub-multiple units	5021-112-130 Metric Notation ▪ Convert decimal numbers to powers of ten and vice versa. ▪ Convert decimal numbers to metric prefixes and vice versa. ▪ Add, subtract, multiply, and divide powers of ten. ▪ Add, subtract, multiply, and divide metric prefixes. 5021-112-190 Resistors ▪ Identify the purpose of a resistor. ▪ Identify the unit of resistance as the ohm. ▪ Identify the resistor reference designator code. ▪ Identify resistor schematic symbols. ▪ Identify fixed resistors. ▪ Identify variable resistors. ▪ Define power rating. ▪ Define tolerance. ▪ Identify number/letter codes. 5021-112-220 Switches, Fuses, and Circuit Breakers ▪ Identify the purpose of a switch. ▪ Identify switch schematic symbols. ▪ Describe Single and Double Pole. ▪ Describe Single and Double Throw. ▪ Describe four types of switches. ▪ Identify the schematic symbol for each switch. ▪ Identify the purpose of protection devices. ▪ identify a fuse and a circuit breaker. ▪ Identify schematic symbols for fuses and circuit breakers. 5021-112-250 Tools for Electronic Troubleshooting ▪ Identify the basic hand tools used for troubleshooting and repair. ▪ Describe the types of tasks performed with each tool. ▪ Describe the safe and proper use of hand tools. 5021-112-910 Introduction to Electricity Post-Test (Theory) .	
T3 Ohm’s Law encompassing: • basic d.c. single path circuit. • voltage and currents levels in a basic d.c. single path circuit. • effects of an open-circuit, a closed-circuit and a short-circuit on a basic d.c. single path relationship between voltage and current from measured values in a simple circuit	5021-116-130 Ohm's Law and Power ▪ Learn what Ohm's Law is and how voltage, current, and resistance are related. ▪ Learn what power is and how voltage, current, and Ohm's Law are related to power. ▪ Prove the Ohm's Law relationship of voltage, current, and resistance.	5

• determining voltage, current and resistance in a circuit given any two of these quantities • graphical relationships of voltage, current and resistance • relationship between voltage, current and resistance		
T4 Electrical power encompassing: • relationship between force, power, work and energy • power dissipated in circuit from voltage, current and resistance values • power ratings of devices • measurement electrical power in a d.c. circuit effects of power rating of various resistors	5021-116-130 Ohm's Law and Power ▪ Learn what Ohm's Law is and how voltage, current, and resistance are related. ▪ Learn what power is and how voltage, current, and Ohm's Law are related to power. ▪ Prove the Ohm's Law relationship of voltage, current, and resistance.	5
T5 Effects of electrical current encompassing: • physiological effects of current and the fundamental principles (listed in AS/NZS 3000) for protection against the this effect • basic principles by which electric current can result in the production of heat; the production of magnetic fields; a chemical reaction • typical uses of the effects of current • mechanisms by which metals corrode • fundamental principles (listed in AS/NZS3000) for protection against the damaging effects of current •		
T6 EMF sources energy sources and conversion electrical energy encompassing: • basic principles of producing a emf from the interaction of a moving conductor in a magnetic field.		

• basic principles of producing an emf from the heating of one junction of a thermocouple. • basic principles of producing a emf by the application of sun light falling on the surface of photovoltaic cells • basic principles of generating a emf when a mechanical force is applied to a crystal (piezo electric effect) • principles of producing a electrical current from primary, secondary and fuel cells • input, output, efficiency or losses of electrical systems and machines • effect of losses in electrical wiring and machines • principle of conservation of energy		
T7 Resistors encompassing: • features of fixed and variable resistor types and typical applications • identification of fixed and variable resistors • various types of fixed resistors used in the Electro technology Industry. e.g. wire-wound, carbon film, tapped resistors. • various types of variable resistors used in the Electro technology Industry e.g. adjustable resistors: potentiometer and rheostat; light dependent resistor (LDR); voltage dependent resistor (VDR) and temperature dependent resistor (NTC, PTC). • characteristics of temperature, voltage and light dependent resistors and typical applications of each • power ratings of a resistor. • power loss (heat) occurring in a conductor. • resistance of a colour coded resistor from colour code tables and confirm the value by measurement.	5021-112-190 Resistors ▪ Identify the purpose of a resistor. ▪ Identify the unit of resistance as the ohm. ▪ Identify the resistor reference designator code. ▪ Identify resistor schematic symbols. ▪ Identify fixed resistors. ▪ Identify variable resistors. ▪ Define power rating. ▪ Define tolerance. ▪ Identify number/letter codes.	

• measurement of resistance of a range of variable' resistors under varying conditions of light, voltage, temperature conditions. • specifying a resistor for a particular application.		
T8 Series circuits encompassing: • circuit diagram of a single-source d.c. 'series' circuit. • Identification of the major components of a 'series' circuit: power supply; loads; connecting leads and switch • applications where 'series' circuits are used in the Electro technology industry. • characteristics of a 'series' circuit - connection of loads, current path, voltage drops, power dissipation and affects of an open circuit in a 'series' circuit. • the voltage, current, resistances or power dissipated from measured or given values of any two of these quantities • relationship between voltage drops and resistance in a simple voltage divider network. • setting up and connecting a single-source series dc circuit • measurement of resistance, voltage and current values in a single source series circuit • effect of an open-circuit on a series connected circuit	5021-116-160 Series Circuits ▪ Identify a series circuit. ▪ Calculate total resistance in a series circuit. ▪ Calculate current in a series circuit. ▪ Calculate voltage drops across resistance. ▪ Measure current values in a series circuit. ▪ Measure voltage drops in a series circuit. 5021-116-190 Series Circuit Troubleshooting Theory ▪ Follow a logical troubleshooting procedure. ▪ Identify an open, short, and a changed value component in a series circuit. ▪ Analyze a series circuit and determine if the circuit is defective. 5021-116-220 Series Circuit Troubleshooting Experiment ▪ Determine if a series circuit is open and identify which component is open. ▪ Determine if a series circuit has a short and identify which component is shorted. ▪ Determine if a series circuit has a changed value and identify which resistor has a changed value. 5021-116-250 Series Circuit Troubleshooting Practice ▪ Troubleshoot a series circuit and identify if the circuit is operating properly. ▪ Identify a faulted circuit as being open, shorted, or changed value. ▪ Identify the component most likely to cause the fault. 5021-118-130 Voltage Divider Circuits ▪ Identify a voltage divider circuit. ▪ Identify a voltage divider as being loaded or unloaded. ▪ Calculate voltage, current, and resistance for loaded and unloaded voltage dividers. ▪ Calculate % regulation for a voltage divider circuit. ▪ Measure unloaded voltage divider voltages.	6A 6A 6A 9C

	▪ Measure loaded voltage divider voltages. 5021-118-190 Introduction to Kirchhoff's Voltage and Current Laws ▪ Identify a complex circuit. ▪ State Kirchhoff's Current Law. ▪ State Kirchhoff's Voltage Law. ▪ Compare calculated and measured voltage in a circuit using Kirchhoff's Laws.	9C

T9 Parallel circuits encompassing: • schematic diagram of a single-source d.c. 'parallel' circuit. • major components of a 'parallel' circuit (power supply, loads, connecting leads and switch) • applications where 'parallel' circuits are used in the Electrotechnology industry. • characteristics of a 'parallel' circuit. (load connection, current paths, voltage drops, power dissipation, affects of an open circuit in a 'parallel' circuit). • relationship between currents entering a junction and currents leaving a junction • relationship between branch currents and resistances in a two branch current divider network. • calculation of the total resistance of a 'parallel' circuit. • calculation of the total current of a 'parallel' circuit. • Calculation of the total voltage and the individual voltage drops of a 'parallel' circuit. • setting up and connecting a single-source d.c. parallel circuit • resistance, voltage and current measurements in a single-source parallel circuit • voltage, current, resistance or power dissipated from measured values of any of these quantities • output current and voltage levels of connecting cells in parallel.	5021-116-280 Parallel Circuits ▪ Identify a parallel circuit. ▪ Recognize that the applied voltage is the same across each branch. ▪ Calculate current in each branch of a parallel circuit. ▪ Calculate total current from the sum of the individual branches of a parallel circuit. ▪ Calculate total resistance in a parallel circuit. ▪ Measure the applied voltage across each branch in a parallel circuit. ▪ Measure current across each branch in a parallel circuit. ▪ Measure total resistance in a parallel circuit. 5021-116-310 Parallel Circuit Troubleshooting Theory ▪ Identify an open, short, and changed value component in a parallel circuit. ▪ Analyze a parallel circuit and determine if the circuit is defective. 5021-116-340 Parallel Circuit Troubleshooting Experiment ▪ Determine if a parallel circuit is open and identify which component is open. ▪ Determine if a parallel circuit has a short and identify which component is shorted. ▪ Determine if a parallel circuit has a changed value and identify which resistor has changed value. 5021-116-370 Parallel Circuit Troubleshooting Practice ▪ Troubleshoot a parallel circuit and identify if the circuit is operating properly. ▪ Identify a faulted circuit as being open, shorted, or changed value. ▪ Identify the component most likely to cause the fault. 5021-118-160 Bridge Circuits ▪ State the purpose of a bridge circuit. ▪ Identify a bridge circuit. ▪ Solve for voltage outputs. ▪ Solve for unknown resistance. ▪ Voltage measurements. ▪ Resistance measurements.	8A 8A 8A 10A
T10 Series/parallel circuits encompassing: • schematic diagram of a single-source d.c. 'series/parallel' circuit.	5021-116-400 Series-Parallel Circuits ▪ Identify a series-parallel circuit. ▪ Calculate total resistance in a series-parallel circuit. ▪ Calculate current in a series-parallel circuit. ▪ Calculate voltage drops in a series-parallel circuit.	9A

• major components of a 'series/parallel' circuit (power supply, loads, connecting leads and switch) • applications where 'series/parallel' circuits are used in the Electrotechnology industry. • characteristics of a 'series/parallel' circuit. (load connection, current paths, voltage drops, power dissipation, affects of an open circuit in a 'series/parallel' circuit). • relationship between voltages, currents and resistances in a bridge network. • calculation of the total resistance of a 'series/parallel' circuit. • calculation of the total current of a 'series/parallel' circuit. • calculation of the total voltage and the individual voltage drops of a 'series/parallel' circuit. • setting up and connecting a single-source d.c. series/ parallel circuit • resistance, voltage and current measurements in a single-source d.c. series / parallel circuit • the voltage, current, resistances or power dissipated from measured values of any two of these quantities	▪ Measure resistance values in a series-parallel circuit. ▪ Measure current values in a series-parallel circuit. ▪ Measure voltage drops in a series-parallel circuit. 5021-116-430 Series-Parallel Circuit Troubleshooting Theory ▪ Identify an open, short, and changed value component in a series-parallel circuit. ▪ Analyze a series-parallel circuit and determine if the circuit is defective. 5021-116-460 Series-Parallel Circuit Troubleshooting Experiment ▪ Determine if a series-parallel circuit is open and identify which component is open. ▪ Determine if a series-parallel circuit has a short and identify which component is shorted. ▪ Determine if a series-parallel circuit has a changed value and identify which component has a changed value. 5021-116-490 Series-Parallel Circuit Troubleshooting Practice ▪ Troubleshoot a series-parallel circuit and identify if the circuit is operating properly. ▪ Identify a faulted circuit as being open, shorted, or changed value. ▪ Identify the component most likely to cause the fault. 5021-116-920 Basic DC Circuits Post-Test (Theory)	9A 9A
T11 Factors affecting resistance encompassing: • four factors that affect the resistance of a conductor (type of material, length, cross-sectional area and temperature) • affect the change in the type of material (resistivity) has on the resistance of a conductor. • affect the change in 'length' has on the resistance of a conductor. • affect the change in 'cross-sectional area' has on the resistance of a conductor.		

• effects of temperature change on the resistance of various conducting materials • effects of resistance on the current-carrying capacity and voltage drop in cables. • calculation of the resistance of a conductor from factors such as conductor length, cross-sectional area, resistivity and changes in temperature • using digital and analogue ohmmeter to measure the change in resistance of different types of conductive materials (copper, aluminium, nichrome, tungsten) when those materials undergo a change in type of material length, cross-sectional area and temperature.		
T12 Effects of meters in a circuit encompassing: • selecting an appropriate meter in terms of units to be measured, range, loading effect and accuracy for a given application. • measuring resistance using direct, volt-ammeter and bridge methods. • instruments used in the field to measure voltage, current, resistance and insulation resistance and the typical circumstances in which they are used. • hazards involved in using electrical instruments and the safety control measures that should be taken. • operating characteristics of analogue and digital meters. • correct techniques to read the scale of an analogue meters and how to reduce the 'parallax' error. • types of voltmeters used in the Electrotechnology industry – bench type, clamp meter, Multimeter, etc.	5021-114-130 Magnetism, Relays, and Meters ▪ Define magnetism. ▪ Identify characteristics of magnets. ▪ Define laws of magnetic attraction and repulsion. ▪ Describe properties of magnetic lines of force. ▪ Identify non-magnetic materials. ▪ Define electromagnetism. ▪ Identify the characteristics of electromagnetism. ▪ Describe the operation of a relay. ▪ Describe the operation of a magnetic circuit breaker. ▪ Describe the operation of a meter. 5021-114-160 Introduction to Multimeters ▪ Identify the quantities measured by multimeters. ▪ Identify multimeter characteristics. ▪ Describe the functional sections of a digital multimeter. ▪ Describe the purpose of each functional section. 5021-114-190 Multimeter Use ▪ Understand how to operate a digital multimeter. ▪ Operate a digital multimeter. 5021-114-220 Voltage Measurements ▪ Describe how to set up a digital multimeter to measure voltage. ▪ Understand how to read a digital multimeter's display when	CF 2

• purpose and characteristics (internal resistance, range, loading effect and accuracy) of a voltmeter. • types of voltage indicator testers. e.g. LED, neon, solenoid, volt-stick, series tester, etc. and explain the purpose of each voltage indicator tester. • operation of various voltage indicator testers. • advantages and disadvantages of each voltage indicator tester. • various types of ammeters used in the Electrotechnology industry – bench, clamp meter, multimeter, etc. • purpose of an ammeter and the correct connection (series) of an ammeter into a circuit. • reasons why the internal resistance of an ammeter must be extremely low and the dangers and consequences of connecting an ammeter in parallel and/or wrong polarity. • selecting an appropriate meter in terms of units to be measured, range, loading effect and accuracy for a given application • connecting an analogue/digital voltmeter into a circuit ensuring the polarities are correct and take various voltage readings. • loading effect of various voltmeters when measuring voltage across various loads. • using voltage indicator testers to detect the presence of various voltage levels. • connecting analogue/digital ammeter into a circuit ensuring the polarities are correct and take various current readings.	measuring voltage. ▪ Describe the correct way to connect a multimeter to a circuit for measuring voltage. ▪ Perform voltage measurements with a digital multimeter. 5021-114-250 Current Measurements ▪ Describe how to set up a digital multimeter to measure current. ▪ Describe how to read a digital multimeter's display when measuring current. Describe the correct way to connect a multimeter to a circuit for measuring current. ▪ Identify the precautions to observe when making current measurements. ▪ Perform current measurements with a digital multimeter. 5021-114-280 Resistance Measurements ▪ Describe how to set up a digital multimeter to measure resistance. ▪ Understand how to read a digital multimeter's display when measuring resistance. ▪ Describe the correct way to connect a multimeter to a circuit for measuring resistance. ▪ Identify the precautions to observe when making resistance measurements. ▪ Perform resistance measurements with a digital multimeter. 5021-114-910 Multimeter Use Post-Test (Theory) 5021-118-310 Multimeter Loading ▪ Describe the circuit loading effect of multimeters. ▪ Describe how the multimeter loading is reduced. ▪ Describe the Ohms per volt rating of analog multimeters. ▪ Measure circuit voltages using an analog and digital multimeter. ▪ Observe the loading effect of an analog multimeter.	4A 4A 9C
T13 Resistance measurement encompassing: • Identification of instruments used in the field to measure resistance (including insulation resistance) and the typical	5021-114-280 Resistance Measurements ▪ Describe how to set up a digital multimeter to measure resistance. ▪ Understand how to read a digital multimeter's display when measuring resistance. ▪ Describe the correct way to connect a multimeter to a circuit for	4A

circumstances in which they are used. • the purpose of an Insulation Resistance (IR) Tester. • the parts and functions of various analogue and digital IR Tester (selector range switch, zero ohms adjustment, battery check function, scale and connecting leads). • reasons why the supply must be isolated prior to using the IR tester. • where and why the continuity test would be used in an electrical installation. • where and why the insulation resistance test would be used in an electrical installation. • the voltage ranges of an IR tester and where each range may be used. e.g. 250 V d.c, 500 V d.c and 1000 V d.c • AS/NZS3000 Wiring Rules requirements – continuity test and insulation resistance (IR) test. • purpose of regular IR tester calibration. • the correct methods of storing the IR tester after use • carry out a calibration check on a IR Tester • measurement of low values of resistance using an IR tester continuity functions. • measurement of high values of resistance using an IR tester insulation resistance function. • volt-ammeter (short shunt and long shunt) methods of measuring resistance. • calculation of resistance values using voltmeter and ammeter reading (long and short shunt connections) • measurement of resistance using volt-ammeter methods	measuring resistance. ▪ Identify the precautions to observe when making resistance measurements.	
T14 Capacitors and Capacitance encompassing:	5021-318-130 Introduction to Capacitors ▪ Identify types of capacitors. ▪ Describe charge and discharge characteristics of a capacitor.	

• basic construction of standard capacitor, highlighting the: plates, dielectric and connecting leads • different types of dielectric material and each dielectric's relative permittivity. • identification of various types of capacitors commonly used in the Electrotechnology industry (fixed value capacitors -stacked plate, rolled, electrolytic, ceramic, mica and Variable value capacitors – tuning and trimmer) • circuit symbol of various types of capacitors: standard; variable, trimmer and polarised • terms: Capacitance (C), Electric charge (Q) and Energy (W) • unit of: Capacitance (Farad), Electric charge (Coulomb) and Energy (Joule) • factors affecting capacitance (the effective area of the plates, the distance between the plates and the type of dielectric) and explain how these factors are present in all circuits to some extent. • how a capacitor is charged in a d.c. circuit. • behaviour of a series d.c. circuit containing resistance and capacitance components. - charge and discharge curves • the term 'Time Constant' and its relationship to the charging and discharging of a capacitor. • calculation of quantities from given information: Capacitance (Q = VC); Energy (W =½CV2); Voltage (V = Q/C) • calculation one time constant as well as the time taken to fully charge and discharge a given capacitor. (τ = RC) • connection of a series d.c. circuit containing capacitance and resistor to determine the time constant of the circuit	▪ Identify the schematic symbol for a capacitor ▪ Identify characteristics of capacitance. ▪ Identify the unit of measurement for capacitance 5021-318-160 Capacitor Identification . ▪ Identify ceramic, film, mica, and electrolytic capacitors. ▪ Read the capacitance and voltage values. 5021-318-190 RC Series Circuits ▪ Calculate total capacitance in series circuits. ▪ Calculate total capacitive reactance in series circuits. ▪ Calculate total impedance in series circuits. 5021-320-160 RC Time Constants Operation ▪ Observe capacitor charging and discharging using a multimeter. ▪ Observe capacitor charging and discharging using an oscilloscope. ▪ Verify RC time constants by the use of measurements.	11 15

T15 Capacitors in Series and Parallel encompassing: • hazards involved in working with capacitance effects and the safety control measures that should be taken. • safe handling and the correct methods of discharging various size capacitors • dangers of a charged capacitor and the consequences of discharging a capacitor through a person • factors which determine the capacitance of a capacitor and explain how these factors are present in all circuits to some extent. • effects of capacitors connected in parallel by calculating their equivalent capacitance. • effects on the total capacitance of capacitors connected in series by calculating their equivalent capacitance. • Connecting capacitors in series and/or parallel configurations to achieve various capacitance values. • common faults in capacitors. • testing of capacitors to determine serviceability. application of capacitors in the Electrotechnology industry.		

Performance Tests available for this competency:

5021-114-960 Multimeter Use Post-Test (Performance)	Cards: 2W, 4AW
5021-116-960 Basic DC Circuits Post-Test (Performance)	Cards: 9AW