Training Package	Electrotechnology (UEE07)			HSC Requirements and Advice
Unit title	**Solve problems in multiple path d.c. circuits**			HSC Indicative Hours
Unit code	**UEENEEE004B**	Competency field	Electrotechnology	**35**

Unit descriptor	This unit covers determining correct operation of single source d.c. parallel and series-parallel circuits and providing solutions as they apply to various electrotechnology work functions. It encompasses working safely, problem solving procedures, including the use of voltage, current and resistance measuring devices, providing solutions derived from measurements and calculations to predictable problems in multiple path circuit.
Application of the unit	This unit is intended for competency development entry-level employment based programs incorporated in approved contracts of training.
Employability skills	The required outcomes described in this unit of competency contain applicable facets of Employability Skills. The Employability Skills Summary of the qualification in which this unit of competency is packaged will assist in identifying Employability Skills requirements.
Prerequisite unit(s)	**Competencies** Granting competency in this unit shall be made only after competency in the following unit(s) has/have been confirmed: • UEENEEE003B Solve problems in extra-low voltage single path circuits. For the full prerequisite chain details for this unit please refer to Table 2 in Volume 1, Part 2 [of UEE07 Training Package].
	Literacy and numeracy skills Participants are best equipped to achieve competency in this unit if they have reading, writing and numeracy skills indicated by the following scales. Description of each scale is given in *Appendix 1* of this Syllabus. Reading 3 Writing 3 Numeracy 3
Licence to practise	The skills and knowledge described in this unit requires a licence to practise in the workplace where plant and equipment is directly connected to installation wiring that operates at voltage above 50 V a.c. or 120 V d.c. However other conditions may apply in some jurisdictions subject to regulations related to electrical work. Practice in the workplace and during training is also subject to regulations directly related to occupational health and safety and where applicable contracts of training such as apprenticeships.

Required Skills and Knowledge	HSC Requirements and Advice
This describes the essential skills and knowledge and their level **required** for this unit. Evidence shall show that knowledge has been acquired of safe working practices and solving problems in multiple path d.c. circuits. All knowledge and skills detailed in this unit should be contextualised to current industry practices and technologies. The extent of the essential knowledge and associated skills (EKAS) required is given in *Appendix 2* of this Syllabus. It forms an integral part of this unit. 2.8.2.1 Direct current circuit principles 2.18.1 Occupational Health and Safety principles.	**Key Terms and Concepts** • approval and sign-off • authorise/appropriate personnel • circuit problems • clean-up procedures • common/predictable problems • 'dead' • electrical principles in relation to: - capacitance - capacitors - factors effecting resistance - measurement of electrical quantities - parallel circuits - resistors - series circuits • fault-finding and problem-solving • faulty tools and equipment • general features, purpose, maintenance and working knowledge of tools, equipment and testing devices • hazard identification and risk control • isolating a device • 'live' • material safety data sheet (MSDS) • measurement and calculations • modes of communication • multiple path d.c. circuits • obtaining, understanding and clarifying instructions/procedures • occupational health and safety (OHS) • 'off-line' • 'on-line' • personal protective equipment (PPE) • reporting and recording • safe work practices and procedures • selection and safe use of equipment • solutions to a range of common problems • sources of information • sustainable energy practices • work records • working safely with electricity • workplace/enterprise policy and procedures.

Evidence Guide

This provides essential advice for assessment of the unit. It must be read in conjunction with the Performance Criteria and the Range Statement of the unit and the Training Package Assessment Guidelines.

The Evidence Guide forms an integral part of this unit. It must be used in conjunction with all parts of the unit and performed in accordance with the Assessment Guidelines of this Training Package.

Overview of assessment	Critical aspects of evidence required to demonstrate competency in this unit
Longitudinal competency development approaches to assessment, such as Profiling, require data to be reliably gathered in a form that can be consistently interpreted over time. This approach is best utilised in Apprenticeship programs and reduces assessment intervention. It is the industry-preferred model for apprenticeships. However, where summative (or final) assessment is used it is to include the application of the competency in the normal work environment or, at a minimum, the application of the competency in a realistically simulated work environment. It is recognised that, in some circumstances, assessment in part or full can occur outside the workplace. However, it must be in accordance with industry and regulatory policy. Methods chosen for a particular assessment will be influenced by various factors. These include the extent of the assessment, the most effective locations for the assessment activities to take place, access to physical resources, additional safety measures that may be required and the critical nature of the competencies being assessed. The critical safety nature of working with electricity, electrical equipment, gas or any other hazardous substance/material carries risk in deeming a person competent. Sources of evidence need to be 'rich' in nature to minimise error in judgement. Activities associated with normal everyday work have a bearing on the decision as to how much and how detailed the data gathered will contribute to its 'richness'. Some skills are more critical to safety and operational requirements while the same skills may be more or less frequently practised. These points are raised for the assessors to consider when choosing an assessment method and developing assessment instruments. Sample assessment instruments are included for Assessors in the Assessment Guidelines of this Training Package.	Before the critical aspects of evidence are considered all prerequisites must be met. Evidence for competence in this unit shall be considered holistically. Each element and associated performance criteria shall be demonstrated on at least two occasions in accordance with the 'Assessment Guidelines – UEE07'. Evidence shall also comprise: • a representative body of performance criteria demonstrated within the timeframes typically expected of the discipline, work function and industrial environment. In particular this shall incorporate evidence that shows a candidate is able to: - implement Occupational Health and Safety workplace procedures and practices, including the use of risk control measures as specified in the performance criteria and range statement - apply sustainable energy principles and practices as specified in the performance criteria and Range Statement - demonstrate an understanding of the essential knowledge and associated skills as described in this unit. It may be required by some jurisdictions that RTOs provide a percentile graded result for the purpose of regulatory or licensing requirements. - demonstrate an appropriate level of skills enabling employment - conduct work observing the relevant Anti Discrimination legislation, regulations, polices and workplace procedures • demonstrated consistent performance across a representative range of contexts from the prescribed items below: - solving problems in multiple path d.c. circuits including: ▪ determining the operating parameters of an existing circuit ▪ alternating an existing circuit to comply with specified operating parameters ▪ developing circuits to comply with a specified function and operating parameters ▪ dealing with unplanned events by drawing on essential knowledge and skills to provide appropriate solutions incorporated in a holistic assessment with the above listed items.

Evidence Guide cont/d

Context of and specific resources for assessment	Method of assessment	Concurrent assessment and relationship with other units
This unit should be assessed as it relates to normal work practice using procedures, information and resources typical of a workplace. This should include: • OHS policy and work procedures and instructions • suitable work environment, facilities, equipment and materials to undertake actual work as prescribed in this unit. These should be used in the formal learning/assessment environment. Note: Where simulation is considered a suitable strategy for assessment, conditions for assessment must be authentic and as far as possible reproduce and replicate the workplace and be consistent with the approved industry simulation policy. The resources used for assessment should reflect current industry practices in relation to solving problems in multiple path d.c. circuits.	This unit shall be assessed by methods given in *Appendix 3* of this Syllabus. Note: Competent performance with inherent safe working practices is expected in the Industry to which this unit applies. This requires that the specified essential knowledge and associated skills are assessed in a structured environment which is primarily intended for learning/assessment and incorporates all necessary equipment and facilities for learners to develop and demonstrate the essential knowledge and skills described in this unit.	There are no concurrent assessment recommendations for this unit. The critical aspects of Occupational Health and Safety covered in UEENEEE001B and other discipline specific Occupational Health and Safety unit(s) shall be reassessed in relation to this unit.

Element	Performance Criteria	Range Statement	HSC Requirements and Advice
1 Prepare to work on multiple path d.c. electrical circuits	1.1 OHS procedures for a given work area are identified, obtained and understood.	This relates to the unit as a whole providing the range of contexts and conditions to which the Performance Criteria apply. It allows for different work environments and situations that will affect performance. This unit shall be demonstrated in relation to: • single source parallel and series-parallel d.c. circuits as they apply to problems related to installation, fault finding, maintenance or development work functions in any of the following disciplines: - computers - data communications - electrical - electronics - fire protection - instrumentation - refrigeration and air conditioning, and • and in relation to at least two of the following types of circuit problems and on at least two occasions: - determining the operating parameters of an existing circuit - alternating an existing circuit to comply with specified operating parameters - developing circuits to comply with a specified function and operating parameters. Generic terms used throughout this Vocational Standard shall be regarded as part of the Range Statement in which competency is demonstrated. The definition of these and other terms that apply are given in *Appendix 4* of this Syllabus.	**Learning experiences for the HSC must address:** Strategies for obtaining, understanding and clarifying instructions/procedures including: • correct sourcing and selection of information • consulting appropriate personnel • active listening • open and closed questions. An awareness of sources of information regarding occupational health and safety (OHS) in the workplace including:· • workplace/enterprise policies and procedures • schedule of work • standard operating procedures (SOP) • job safety analysis (JSA) • emergency plan • training manuals • WorkCover NSW and Australian Safety and Compensation Council (ASCC) [formerly National Occupational Health and Safety Commission (NOHSC)] publications/safety alerts • legislation/regulations/codes of practice • material safety data sheets (MSDS) • Australian Standards • manufacturer's specifications. An awareness of various modes of communication to receive work instructions including: • verbal - face to face (supervisor to employee) - telephone/mobile phone - workplace meetings • written communication - work plans - memos/messages - job descriptions/statements - workplace forms - rosters • non-verbal - signage - diagrams.

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			A basic understanding of OHS legislation. An awareness of safe work practices and procedures for a workplace within the electrotechnology environment. Working safely with electricity.
	1.2 OHS risk control work preparation measures and procedures are followed.		**Learning experiences for the HSC must address:** A basic understanding of risk management including how to: • identify hazards • assess associated risks • use appropriate control measures to eliminate or minimise risks • monitor and review the control measures. A basic awareness of the hierarchy of risk control measures: • Level 1 – eliminate the risk (such as discontinue the activity and not use the equipment) • Level 2 – minimise the risk by: - substituting the system of work/equipment (with something safer) - modifying the system of work/equipment (to make it safer) - isolating the hazard (such as introducing a restrictive work area) - introducing engineering control • Level 3 – other controls - adopting administrative controls and safe working practices - useing PPE.
	1.3 The nature of the circuit(s) problem is obtained from documentation or from work supervisor to establish the scope of work to be undertaken.		**Learning experiences for the HSC must address:** An understanding of electrical principles in relation to factors affecting resistance including: • factors affecting resistance of conductors - length - cross-sectional area - materials • effects of temperature change on the resistance of various conducting materials

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			• the resistance of a conductor from: - conductor length - cross-sectional area - resistivity - changes in temperature • effects of resistance on the current-carrying capacity and voltage drop in cables. An understanding of electrical principles in relation to resistors including: • fixed and variable resistors - types - features - typical applications • temperature, voltage and light-dependent resistors - characteristics - typical applications • specifying a resistor for a particular application • resistance of a colour-coded resistor from colour code table and confirmation of the value by measurement. An understanding of electrical principles in relation to series circuits including: • setting up and connecting a single-source series d.c. circuit • measurement of resistance, voltage and current values in a single-source series circuit • the voltage, current, resistances or power dissipated from measured or given values of any two of these quantities • relationship between the voltage drops - around a circuit and the applied voltage - resistance in a simple voltage divider network • output voltage and current levels of connecting cells in series. An understanding of electrical principles in relation to parallel circuits including: • setting up and connecting a single-source parallel circuit • measurement of resistance, voltage and current values in a single-source parallel circuit • the voltage, current, resistance or power dissipated

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			from measured or given values of any of these quantities • relationship between currents entering a junction and currents leaving a junction • relationship between branch currents and resistances in a two-branch current divider network • voltage and current levels of connecting cells in parallel. An understanding of electrical principles in relation to capacitance including: • defining capacitance • explaining how a capacitor is charged • the units by which capacitance is measured • the relationship between capacitance, voltage and charge • the behaviour of a series d.c. circuit containing resistance and capacitance components. An understanding of electrical principles in relation to capacitors including: • hazards involved in working with capacitance effects and the safety control measures that should be taken • factors which determine the capacitance of a capacitor and 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 • common faults in capacitors • the testing of capacitors to determine serviceability. An awareness of common/predictable problems in multiple path d.c. circuits including those related to: • installation • fault-finding • maintenance • development work functions.
	1.4 Advice is sought from the work supervisor to ensure the work is coordinated effectively with others.		**Learning experiences for the HSC must address:** An understanding of the relationship between individual

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			roles and the role of the team/group and/or others in the workplace/enterprise. A basic understanding of the primary role(s) and duties/services performed by a range of personnel.
	1.5 Sources of material that may be required for the work are identified and accessed in accordance with established procedures.		**Learning experiences for the HSC must address:** A working knowledge of the following to enable the calculation of quantities for projects: • appropriate units of measurement • scale drawings • stock sizes • materials lists • waste minimisation. Measurements, calculations and determination of material quantities for a range of projects of varying complexity. An awareness of the consequences of incorrect measurements and calculations for: • the client • the organisation/company • the environment. Correct handling, application, transport and storage of hazardous and non-hazardous materials used in a range of electrotechnology projects. An awareness of information provided in material safety data sheets (MSDS) including: • manufacturer's/supplier's details • physical description and properties • identification of substance • use • ingredients • health hazard information • first aid • precautions for use • safe handling information • control point. How and where to obtain required MSDS.

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	1.6 Tools, equipment and testing devices needed to carry out the work are obtained and checked for correct operation and safety.		**Learning experiences for the HSC must address:** An understanding of electrical principles in relation to measurement of electrical quantities including: • hazards involved in using electrical instruments and the safety control measures that should be taken • operating characteristics of analogue and digital meters • selecting an appropriate meter in terms of - units to be measured - range - loading effect - accuracy • measuring resistance using - direct - volt-ammeter - bridge methods • instruments used in the field to measure voltage, current, resistance and insulation resistance and the typical circumstances in which they are used. General features, purpose, maintenance and working knowledge of a range of tools, equipment and testing devices including: • screwdrivers • pliers • wire strippers • soldering iron • multimeter. Considerations for the selection of tools and equipment including: • skills/training • licensing requirements • time • cost • OHS requirements - job safety analysis (JSA)/safe work method statement - risk assessment • appropriateness for purpose.

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			Selection, use and maintenance of personal protective equipment (PPE). Pre-operational checks including: • safety • consumables • adjustment/alignment for job task. Procedures and documentation for identifying faulty tools and equipment including: • malfunctions • worn, broken or missing components • broken or missing safety guards. Solutions to a range of potential faults. Reporting of serious faults including: • verbal notification to appropriate personnel - supervisor/manager - supplier/manufacturer • recording on job card/maintenance log • safety/lockout tagging where appropriate. Reasons for safety/lockout tagging including: • ease of identification • evidence of serviceability • preventing use until repaired.
2 Solve multiple path d.c. circuit problems	2.1 OHS risk control work measures and procedures are followed.		
	2.2 The need to test or measure live is determined in strict accordance with OHS requirements and when necessary conducted within established safety procedures.		**Learning experiences for the HSC must address:** Definitions of: • 'live' • 'dead' • 'on-line' • 'off-line'.
	2.3 Circuits are checked as being isolated where necessary in strict accordance with OHS requirements and procedures.		**Learning experiences for the HSC must address:** Describing the process for isolating a device.

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	2.4 Established methods are used to solve d.c. circuit problems from measure and calculated values as they apply to multiple path electrical circuit.		**Learning experiences for the HSC must address:** Fault-finding and problem-solving including how to: • identify a problem • consider a solution • take corrective action • record • follow-up. Circuit problems including: • determining the operating parameters of an existing circuit • alternating an existing circuit to comply with specified operating parameters • developing circuits to comply with a specified function and operating parameters. Solutions to a range of common problems in relation to multiple path d.c. circuits including: • short circuit component • open circuit component • high valve component • low valve component.
	2.5 Unexpected situations are dealt with safely and with the approval of an authorised person.		**Learning experiences for the HSC must address:** An awareness of authorised/appropriate personnel including: • site manager • project manager • line manager • supervisor • team leader • customer's representative.
	2.6 Problems are solved without damage to apparatus, circuits, the surrounding environment or services and using sustainable energy practices.		**Learning experiences for the HSC must address:** Defining: • sustainable energy practices • testing to destruction • soak/endurance testing.

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3 Complete work and document problem solving activities	3.1 OHS work completion risk control measures and procedures are followed.		
	3.2 Work site is cleaned and made safe in accordance with established procedures.		**Learning experiences for the HSC must address:** Clean-up procedures with proper consideration of the environment and OHS. A range of cleaning techniques including: • wiping • washing • brushing • sweeping • scraping • use of cleaning agents (chemicals, solvents and detergents). Cleaning equipment including: • high-pressure water cleaner • wet/dry vacuum • brooms and brushes • scrapers.
	3.3 Justification for solutions used to solve circuit problems is documented.		**Learning experiences for the HSC must address:** An understanding of: • the purpose of work records • workplace/enterprise expectations for the maintenance of work records • types of work records - used in an electrotechnology work environment - required by industry regulation(s) • methods for work records - manual - electronic. The importance of recording information that is: • clear • legible • accurate • concise • appropriate in terms of industry terminology and abbreviations.

Element	Performance Criteria	Range Statement	HSC Requirements and Advice
	3.4 Work completion is documented and appropriate person(s) notified in accordance with established procedures.		**Learning experiences for the HSC must address:** A knowledge of workplace/enterprise practices for final approval and sign-off.