Course outline: 211 AC Theory G102A
UEENEEG102A - Solve problems in low voltage AC circuits

Qualification:	Certificate III in Electrotechnology Electrician - UEE30811
Applicable to:	Learners, industry/employers, governments, community and Global Energy Training Solutions as the provider
Unit of competency:	Accessible from: http://training.gov.au/Training/Details/UEENEEG102A
Related policies:	Policy & Procedure 1 – Enrolment Policy Policy & Procedure 2 – Credit Transfer & Recognition of Prior Learning Policy & Procedure 3 – Learner Support Policy & Procedure 4 – Assessment Policy & Procedure 5 – Academic Misconduct Policy & Procedure 6 – Alcohol & Other Drugs Policy & Procedure 7 – Access, Equity & Diversity Policy & Procedure 8 – Vulnerable People Policy & Procedure 9 – Work, Health & Safety Policy & Procedure 10 – Incident, Injury & Rehabilitation Policy & Procedure 11 – Competency, & Qualification Assessment Decisions Policy & Procedure 12 – Complaints & Appeals Policy & Procedure 13 – Privacy Policy & Procedure 14 – Fees Policy & Procedure 15 – Industry & Employer Engagement Policy & Procedure 16 – Trainers & Assessors Policy & Procedure 17 – Administration & Other Staff Policy & Procedure 18 – Quality Assurance Policy & Procedure 19 – Business & Financial Risk Management Policy & Procedure 20 – Changes to Qualifications or Business Policy & Procedure 21 – Conflict of Interest Policy & Procedure 22 – Records Management Policy & Procedure 23 – Marketing & Advertising
Monitor and review:	Policy & Procedure 18 – Quality Assurance
Responsibility:	Ben Murphy – as Proprietor
Questions/queries:	Feedback and suggestions welcomed: office@gets.com.au (+61) 02 6262 0077

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1. Material requirements

- AS/NZS 3000:2007 incorporating amendment 1 and 2
- Scientific calculator, ruler, pens and pencils
- Note book
- Hand tools
- Covered footwear
- Internet access (provided)

2. Session summaries

Day 1	
Required Skills and Knowledge	T1 Alternating Current quantities encompassing: • sine, cosine and tangent ratios of a right angle triangle • Pythagoras Theorem to a right angle triangle. • use of the CRO to measure d.c. and a.c. voltage levels • sinusoidal voltage generated by a single turn coil rotated in a uniform magnetic fields • terms 'period', 'maximum value', 'peak-to-peak value', 'instantaneous value', 'average value', 'root-mean-square (r.m.s.) value', in relation to a sinusoidal waveform. • calculation of the instantaneous value of induced voltage of a generated sinusoidal waveform. • measurement of instantaneous, peak, peak-to-peak values and the period of a sinusoidal waveform. • calculation of root-mean-square (r.m.s.) value and frequency of a sinusoidal waveform from values of peak voltage and period. T2 Phasors Diagrams encompassing: • purpose of phasor diagrams • 'in-phase', 'out-of-phase', 'phase angle" lead' and 'lag'. • phase angle between two or more alternating quantities from a given sinusoidal waveform diagram. • convention for representing voltage, current and the reference quantity in a phasor diagram. • drawing phasor diagrams to show the relationship between two or more a.c. values of voltage

		and/or current. • determination of phase relationship between two or more sinusoidal waveforms from a given diagram and measurements.

Day 2		
Required Skills and Knowledge	T3	Single Element a.c. circuits encompassing: • setting up and connect a single-source resistive a.c. circuit and take voltage and current measurements to determine the resistance • determining the voltage, current resistances from measure of given values of any tow of these qualities. • relationship between voltage drops and current in resistive a.c. circuit • applications of resistive a.c. circuits • defining 'inductive reactance'. • calculation of inductive reactance for a given inductor and the relationship between inductive reactance and frequency. • applying Ohm's Law to determine voltage, current of inductive reactance in a purely inductive a.c. circuit given any two to these quantities. • applications of inductive a.c circuits. • calculation of capacitive reactance • applying Ohm's Law to determine voltage, current or capacitive reactance in a purely capacitive a.c circuit given any two of the quantities. • applications of capacitive a.c circuits

Day 3		
Required Skills and Knowledge	T4	RC and RL Series a.c. circuits encompassing: • impedance and impedance triangle. • determining the impedance, current and voltages for a series RC circuit given the resistance, capacitance and supply voltage. • drawing and labelling the impedance triangle for a series RC circuit • drawing phasor diagrams for a series RC circuit • AS/NZS 3000 requirements for the installation of capacitors. • examples of capacitive components in power circuits and systems and the effect on the phase relationship between voltage and current. • determining the impedance, current and voltages for a series RL circuit given the resistance, inductance and supply voltage. • drawing and labelling the impedance triangle for a series RL circuit • drawing the equivalent circuit of a practical inductor • Draw phasor diagrams for a series RL circuit. • examples of inductive components in power circuits and systems and describe their effect on the phase relationship between voltage and current

Day 4		
Required Skills and Knowledge	T5	RLC Series a.c. circuits encompassing: • measuring component voltages in a series RLC circuit and using a phasor diagram to determine the supply voltage and phase angle between circuit voltage and circuit current. • determining the impedance, current and voltages for a series RLC circuit given resistance, inductance, capacitance and supply voltage. • drawing and labelling the impedance triangle for a series RLC circuit. • calculation of total impedance for a series RLC circuit. • calculation of voltage drop for cables using the values for reactance and a.c. resistance from AS/NZS 3008. • comparison of current limiting characteristics of inductors and resistors. • practical examples of RLC series circuits

Day 5	
Required Skills and Knowledge	T6 Parallel a.c. Circuits encompassing: • determining the branch currents of a parallel circuit that contain RL, RC or LC in two branches. • using a phasor diagram to determine the total circuit current and phase angle in parallel RL, RC or LC circuits. • determining the total circuit impedance of parallel RL, RC or LC circuits. • measuring the branch currents in a parallel RLC circuit and use a phasor diagram to determine the total current and phase angle between circuit voltage and circuit current. • determining the branch impedances, branch currents and phase angles voltages for a parallel RLC circuit given resistance, inductance, capacitance and supply voltage. • calculation of impedance for a parallel RLC circuit. • practical examples of parallel circuits. T7 Power in an a.c. circuit encompassing: • difference between true power, apparent power and reactive power and the units in which these quantities are measured. • drawing the power triangle to show the relationships between true power, apparent power and reactive power • defining the term "power factor" and phase angle. • methods used to measure single phase power, energy and demand.

Day 6	
Required Skills and Knowledge	T8 Power Factor Improvement encompassing: • effects of low power factor. • requirements for power factor improvement. • methods used to improve low power factor of an installation. • local supply authority and AS/NZS 3000 wiring rules requirements regarding the power factor of an installation and power factor improvement equipment. • methods used to measure single phase power factor. • using manufacturers catalogues to select power factor equipment for a particular installation T9 Harmonics and Resonance Effect in a.c. Systems encompassing: • term "harmonic" in relation to the sinusoidal waveform of an a.c. power system. • sources in a.c. systems that produce harmonics. • problems that may arise in a.c. circuits as a result of harmonics and how these are overcome. • methods and test equipment used to test for harmonics • methods used to reduce harmonics in a.c. power system • conditions in a series a.c. circuit that produce resonance. • dangers of series resonance circuits • conditions in a parallel a.c. circuit that produce resonance. • dangers of parallel resonance circuits • AS/NZS3000 and the local supply authority requirements concerning harmonics and resonance effect in a.c. power systems.

Day 7	
Required Skills and Knowledge	T10 Three Phase Systems encompassing: • features of a multiphase system. • comparison of voltages generated by single and multiphase alternators. • reasons for the adoption of three phases for power systems. • how three phases is generated in a single alternator. • Calculation of r.m.s. value of voltage generated in each phase given the maximum value. • relationship between the phase voltages generated in a three phase alternator and the

	conventions for identifying each. • term "phase sequence" (also, referred to as "phase rotation"). • determining the phase sequence of a three phase supply T11 Three phase star-connections encompassing: • connecting a three phase star-connection load. • phase relationship between line and phase voltages and line and phase currents of a star-connected system. • determining the r.m.s. value of line and phase voltage given any one of these quantities. • determining the r.m.s. value of line and phase current given any one of these quantities. • terms "balanced load" and "unbalanced load". • effect of a reversed phase winding of a star connected alternator. • example of balanced and unbalanced loads in typical power systems.

Day 8	
Required Skills and Knowledge	T12 Three phase four wire systems encompassing: • purpose of the neutral conductor in a three phase four wire systems. • determining the effects of an high impedance in the neutral conductor of a three phase four wire system supplying an unbalanced load where MEN earthing is employed. • determining the value and phase relationship of neutral current in an unbalanced three phase four wire systems given line currents and power factors. • AS/NZS 3000 requirements regarding neutral conductors. • AS/NZS 3008.1.1 method for determining voltage drop in unbalanced three phase circuits T13 Three phase delta-connections and Interconnected systems encompassing: • connecting three phase delta loads. • phase relationship between line and phase voltages and line and phase currents of a delta-connected system. • determining the r.m.s. value of line and phase voltage given any one of these quantities. • determining the r.m.s. value of line and phase current given any one of these quantities. • limitations and uses of open delta connections • effect of a reversed phase winding of a delta connected transformer • example of loads in typical power systems. • drawing the typical combinations of three phase interconnected systems using star-connections and a delta-connection. • relationship between line and phase voltages and line and phase currents in the typical interconnected systems using star-connections and delta-connections.

Day 9	
Required Skills and Knowledge	T14 Energy and power requirements of a.c. systems encompassing: • purposes for measuring power, energy, power factor and maximum demand of a.c. power systems and loads. • difference between true power, apparent power and reactive power and the units in which these quantities are measured in a three phase system. • drawing the power triangle to show the relationships between true power, apparent power and reactive power in a three phase system. • methods used to measure three phase power , energy, power factor and demand. • determining how the power factor of a three phase installation can be improved. • using manufacturers catalogues to select measurement equipment for a particular installation T15 Fault Loop Impedance encompassing: • term fault loop impedance of a a.c. power system • determining fault loop impedance using resistance and reactance values from AS/NZS

	3008.1.1 • measuring fault loop impedance of typical circuits • procedures for testing fault loop impedance

3. Elements and Performance Criteria

Elements and Performance Criteria require practice and demonstration in the work place.

Element		Performance Criteria	Work Performance
1:Prepare to solve low voltage AC circuit problems.	1.1	OHS procedures for a given work area are identified, obtained and understood.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	1.2	Established OHS risk control measures and procedures in preparation for the work are followed.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	1.3	Safety hazards, which have not previously been identified, are noted and established risk control measures are implemented.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	1.4	The nature of the circuit(s) problem is obtained from documentation or from work supervisor to establish the scope of work to be undertaken.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	1.5	Advice is sought from the work supervisor to ensure the work is coordinated effectively with others.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	1.6	Sources of materials that may be required for the work are established in accordance with established procedures.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	1.7	Tools, equipment and testing devices needed to carry out the work are obtained and checked for correct operation and safety.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
2:Solve low voltage AC circuit problems.	2.1	OHS risk control measures and procedures for carrying out the work are followed.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	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.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	2.3	Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	2.4	Established methods are used to solve circuit problems from measure and calculated values as they apply to single and three-phase low voltage circuit.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	2.5	Unexpected situations are dealt with safely and with the approval of an authorised person.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	2.6	Problems are solved without damage to apparatus, circuits, the surrounding environment or services and using sustainable energy practices.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
3:Complete work	3.1	OHS work completion risk control measures and procedures are followed.	☐ Satisfactory ☐ Needs improvement

and document problem solving activities.			☐ Not performed
	3.2	Work site is cleaned and made safe in accordance with established procedures.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	3.3	Justification for solutions used to solve circuit problems is documented.	☐ Satisfactory ☐ Needs improvement ☐ Not performed
	3.4	Work completion is documented and an appropriate person or persons notified in accordance with established procedures.	☐ Satisfactory ☐ Needs improvement ☐ Not performed

4. Assessments

Assessment	When	Satisfactory mark/outcome
Theory assessment 1	Day 3	70%
Theory assessment 2	Day 6	70%
Theory assessment 3	Day 9	70%
Practical assessment 1	Day 4	100%
Practical assessment 2	Day 7	100%
Practical assessment 3	Day 8	100%
Workplace Observation	After theory and practical assessments	Must be valid, sufficient, authentic and current
Employer Competency report		
Structured workplace experience interview		
Note: Once all theory, practical and on-site assessments are complete, competency assessment decisions can be made in conjunction with the learner, employer and registered training organisation.		

5. Version control

Version	Date of release	Author	Authorised by	Position	Rational for change
V1	5/10/2015	Ben Murphy	Ben Murphy	Proprietor	Initial release
V2	7/2/2017	Ben Murphy	Ben Murphy	Proprietor	Added Elements and Performance Criteria