OET003 AC Circuits Rubric Guide **Created August 14, 2017**

The purpose of this guide is to provide a range of knowledge at which students can demonstrate proficiency for each objective. Subsequent college course success depends strongly on courses taught primarily at the "some applied skills demonstrated" and "applied skills strongly demonstrated" levels.

TAG Learning Outcomes	Applied skills strongly demonstrated	Some applied skills demonstrated	Little applied skills demonstrated	No applied skills demonstrated
1. Demonstrate an understanding of the properties of sinusoidal waves.*	• State instantaneous form of sine wave equation for given amplitude, frequency, and phase shift. • Calculate rms and average value using integral calculus. • Add, subtract, multiply, and divide sine waves expressed in instantaneous form. • Instantaneous and average power. • Trigonometric identities.	• Calculate rms and average value of sinusoidal, triangular, square wave, rectangular, and pulse waveforms using "area under the curve" relationships. • Solve for time given amplitude, frequency, and phase shift. • Polarity of voltages and current. • Concept of harmonics.	• Understand the concepts of radians per second and cycles per second. • Convert from hertz to radians per second. • Calculate instantaneous value given amplitude, frequency, and phase shift. • Polarity. • Determine phase shift between two sine waves using the trigger function on an oscilloscope.	• Understand how sine wave of voltage is generated. • Recognize sine wave, peak value, frequency, and phase shift. • Convert radians to degrees and vice versa. • Calculate frequency, period, amplitude, and rms value of sine wave. • Determine amplitude and frequency using an oscilloscope. • Understand the difference between AC and DC coupling function on an oscilloscope.
2. Demonstrate an understanding of and application for phasors and use complex numbers to perform addition and subtraction of phasors.*	• Add, subtract, multiply, and divide phasors using phasor algebra. • Complex apparent power using complex conjugate.	• Law of sines and cosines as applied to phasor analysis. • Polarity of voltage and current using phasor representation.	• Right triangle trigonometry as applied to phasor analysis. • Pythagorean theorem as applied to phasor analysis. • Imaginary numbers and the "j" operator.	• Represent sine wave as magnitude and rms phasor. • Understand phase shift properties of sine waves using phasor representation.

3. Demonstrate a working knowledge of transformer characteristics and applications.*	• Using phasor algebra, reflect voltage and/or current from high to low or low to high. • Reflect complex impedance from high to low or low to high.	• Calculate apparent power loading in volt-amperes. • Understand the difference among apparent, active, and reactive power as related to transformer rating. • Magnetic circuit calculations.	• Understand turns ratio relationships between high side and low side voltage and current. • Understand concept of one to one isolation transformer. • Be aware of transformer losses and heating. • Magnetic materials, permeability, and B-H curves. • NEC installation requirements.	• Understand function of transformer to raise or lower voltage. • Understand basic construction of transformer. • Understand purpose of core. • Purpose of windings. • Magnetic flux, flux density, and magnetomotive force.
4. Analyze the steady-state behavior of RC, RL, and RCL circuits under AC conditions.*	• Using phasor algebra, apply Kirchoff's current law to a node having three or more connections and solve for unknown current. • Using phasor algebra, apply Kirchoff's voltage law to a loop having three or more elements and solve for unknown voltage. • Using phasor algebra, determine parallel impedance of three complex impedances. • Using phasor algebra, determine series impedance of three complex impedances. • Using phasors, apply Nodal analysis to a circuit having three nodes and solve for	• Select voltage and/or current reference in a circuit. • Using phasors, calculate current or voltage in simple circuit. • Using phasor algebra, determine parallel impedance of two complex impedances. • Using phasor algebra, determine series impedance of two complex impedances. • Using phasor algebra, apply Kirchoff's current law to a node having two connections. • Using phasor algebra, apply Kirchoff's voltage law to a loop having two elements.	• Determine impedance magnitude of simple series circuit using Pythagorean theorem. • Determine phase angle of current in a simple series circuit using trigonometry. • Determine total current in a parallel circuit using Pythagorean theorem. • Determine parallel impedance of two complex impedances. • Determine voltage across elements and total voltage in a series circuit using Pythagorean theorem. • Determine series impedance of two complex impedances. • Determine the phase angle between voltages and currents in a circuit using an	• Determine impedance as a function of frequency (frequency response) of capacitor XC and inductor XL. • Function generator operation. • Construct simple circuit and measure voltage and current using multimeter. • Construct simple circuit and measure voltage and current using oscilloscope.

	the node voltages • Using phasors, apply Mesh analysis to a circuit having three or more meshes and solve for mesh currents. • Construct circuit and measure voltages with respect to ground. • Solve circuits using computer simulation.	• Using phasors, apply Nodal analysis to a circuit having two nodes and solve for the node voltages. • Using phasors, apply Mesh analysis to a circuit having two meshes and solve for mesh currents.	oscilloscope.	
5. Design, analyze, and demonstrate an understanding of basic filter circuits.*	• Construct Bode plots of filter circuits. • Determine Bode plots using computer simulation.	• Properties of logarithms. • Low pass and high pass passive filters. • Band pass and band reject passive filters.	• Gain in dB. • Power gain. • Voltage gain. • Frequency response of filter elements.	• Purpose and applications of filter circuits. • Concept of output and input of a filter circuit. • Construct simple filter circuit and measure input and output using function generator, multimeter, and scope.
6. Apply superposition, Thevenin's, and Norton's theorems to the analysis of AC circuits.*	• Using phasor algebra, determine the Thevenin or Norton equivalent of a circuit with one source and three branches. • Lab exercise or computer simulation to verify Thevenin and/or Norton theorems. • Lab exercise or computer simulation to verify Superposition theorem. • Lab exercise or computer	• Convert a Norton equivalent circuit to a Thevenin equivalent circuit and vice versa. • Using phasor algebra, calculate voltages and currents using Superposition in a circuit containing two sources and two loops.	• Perform source conversions using phasor algebra. • Calculate voltages and current in a multi-source series-parallel circuit.	• Concept of equivalent circuit and internal impedance. • Maximum power transfer theorem. • Define and understand purpose of Thevenin and Norton equivalent.

	simulation to verify Maximum Power Transfer theorem.			
7. Demonstrate a basic working knowledge of three-phase and/or poly-phase systems.*	• Using an appropriate reference, determine the phasor representation of line and phase voltages and line and phase currents in an unbalanced three phase system containing complex impedances. • Construct phasor diagram of voltages and currents in unbalanced Wye and Delta systems containing complex impedances. • Perform Wye–Delta and Delta–Wye conversions of unbalanced loads containing complex impedances. • Computer simulations.	• Using an appropriate reference, determine the phasor representation of line and phase voltages and line and phase currents in a balanced three phase system containing complex impedances. • Construct phasor diagram of voltages and currents in balanced Wye and Delta systems containing complex impedances. • Perform Wye–Delta and Delta–Wye conversions of balanced loads containing complex impedances.	• Construct phasor diagram of line and phase voltages in a balanced Wye connected system. • Construct phasor diagram of line and phase currents in a balanced Delta connected system. • Using an appropriate reference, determine the phasor representation of line and phase voltages and line and phase currents in balanced three phase system containing resistive load. • Perform Wye–Delta and Delta–Wye conversions of balanced and unbalanced resistive loads.	• Understand generation of three phase voltages. • Understand 120° phase shift. • Understand relation between line and phase voltage. • Wye and Delta source connections. • Wye and Delta load connections. • Calculate magnitudes of line and phase voltages in a Wye system. • Calculate magnitudes of line and phase currents in a Delta system. • Understand phase rotation. • Grounding.
8. Calculate power factor and demonstrate an understanding of the impact of low power factor.*	• Complex apparent power calculation using complex conjugate of current. • Apparent, active, and reactive power in balanced three phase systems.	• Power factor correction. • Reduction of line current.	• Power triangle. • Use of trigonometry to solve power triangle problems. • Power factor.	• Apparent, active, and reactive power in single phase circuits. • Inductive and capacitive loads. • Reasons for correcting power factor.