Career and Technical Education

9-12/HN Electrical Engineering and Design

BOARD APPROVAL DATE: September 24, 2019

BOARD ADOPTION OF STATE STANDARDS: October 1, 2014

Unit Overview (Standards Coverage)				
Unit	**Standards**	**Unit Focus**	**Skills Overview**	**Suggested Pacing**
Unit 1 AC/DC Circuit Configurations	9.3.ST.3 9.3.ST.4 9.3.ST.5 9.3.ST-ET.2 RST.9-10.1 RST.9-10.2 WHST.9-10.1	Understanding the basics of circuit configurations will establish the critical understanding of how electrical power is developed from voltage, current, and resistance parameters.	While utilizing circuit resistance values to create controlled levels of energy, circuit configurations like the series, parallel, and combination circuits emerge with analysis as to why these circuits establish power and control categories in the industry. Circuits driven by AC or DC are evaluated where applicable for frequency, rms, average values, voltage peaks and peak-to-peak waveforms.	Safety as a means to control non-standard levels of energy existing as a plasma or an undetermined power level should be taught with practical engagements that clarify what can be safely handled v. what needs to be handled with personal protective equipment like gloves, safety glasses, or face shields. (6-8 Weeks)
Unit 2 Passive and Active Components	9.3.ST.3 9.3.ST.4 9.3.ST.5 9.3.ST-ET.2 RST.9-10.1 RST.9-10.2 WHST.9-10.1	Students calculate and confirm true power, apparent power, and reactive power levels developed by passive components that control and shape signal levels going into active components like transistors, fets, and thrystors that amplify, oscillate, and process signals that carry some form of data, signal intelligence, or relative software commands. Use of Digital Multimeters and connecting solar panels to acquire rated voltage and current to drive specific loads.	Passive components like the inductor, capacitor, and the resistor create levels of impedance that influence the amount of power produced in a circuit influencing the surge current which is a level of current moving through a circuit at different times when compared to the circuit voltage and creating a circuit power factor (pf) which at times may have to be corrected.	Passive components that produce true power can be graphed on an oscilloscope. Passive components that produce reactive power can also have reactive components graphed and measured as a phase angle on dual trace oscilloscopes. Resistors should be taught as a true power component. Inductors and capacitors can be taught as reactive power (var) components with phase angles that can be measured or altered when resistive and reactive (L or C) components co-exist. (6 Weeks)
Unit 3 Digital Circuit Design	9.3.ST.3 9.3.ST.4 9.3.ST.5 9.3.ST-ET.2 9.3.ST.6 9.3.MN-PRO.5 9.3.MN-QAO.5 9.3.ST-ET.1 9.3.ST-ET.2	Control circuits that make decisions before the specific output device is driven will become the primary focus of this unit. The output device can be a mechanical or solid state relay, diode or transistor switch, signal amplifier that will respond to a	Circuits that process and qualify logic levels retrieved from nanding, anding, inclusive oring, inclusive noring, with exclusive oring and noring. Operational data tables should be clearly defined as number of input logic states and the maximum number of input sequences with a maximum count.	Control circuits present challenges that must be thoroughly covered in a comprehensive format. Equations that represent circuits should be visualized as a circuit and as a manipulative result. Students need to be able to convert an equation from the visual logic into equations that can be simplified and reconverted back into equations that

	9.3.ST-ET.3 9.3.ST-ET.4 9.3.ST-ET.5 9.3.ST-ET.6 RST.9-10.3 RST.9-10.4 WHST.9-10.1	logical command from the control network.		become circuits. Brief introduction to 48 volt DC telephone circuit and how to understand the telephone number. (12 Weeks)
Unit 4 Small System Prototype Design	9.3.ST-SM.3 9.3.ST-SM.4 9.3.ST.5 9.3.ST-ET.2 9.3.ST.6	Small system circuit design is the assessment core of this unit. Students will be asked to show how to implement a small system designed from previously learned skills to promote independent and critical thinking that develops verified actions, needed in control or power, where verification to solve a previously stated design challenge occurs.	Stated word problem(s) given to (student) designers where the equation is formatted and converted to logic form. This equation will be called the original equation where the rules of algebra (factor, multiply, cancel and combine) will be applied to the original equation to simplify the original hardware in the original equation to simpler hardware in the simple equation. Hardware analysis will be conducted on both equations to verify the validity of the simplification. Once the hardware reductions have been identified, simple equation results will be converted into hardware and the design will be verified as valid and logical from the format of the original word problem.	First review the algebra to facilitate factoring, multiplication, canceling and combining (FMCC). Verify students understand how to convert equations into logic that follow the trend established in the requested design. Repeat these proficiencies as often as needed to establish the learning curve that supports the learning standard. The rules of algebra may very well have to be taught in very small group settings where lengthy repetitions evolve to support memory confirmations. (10 Weeks)

This document outlines in detail the answers to the following four questions:

1. **What do we want our students to know?**
2. **How do we know if they learned it?**
3. **What do we do if they did not learn it?**
4. **What do we do when they did learn it?**

Unit 1 AC/DC Circuit Configurations		
Content & Practice Standards (write in full)	**Interdisciplinary Standards for Practice**	**Critical Knowledge & Skills**
AC/DC Circuit Configurations ● 9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces. ● 9.3.ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy. ● 9.3.ST.5 Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways. ● 9.3.ST-ET.2 Display and communicate STEM information**.**	● RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. ● RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. ● WHST.9-10.1 Write arguments focused on discipline-specific content.	● Student will be able to apply Ohm's law analysis to series, parallel, and combination circuits. ● Student will be able to comprehend why supply voltage is always measured across a switch in a simple series circuit. ● Student will understand the six states of matter, from the twelve states, as they influence the engineering industry identified as solids, liquids, gases, plasmas, bose-einstein condensates, and fermion condensates. ● Student will be able to calculate voltage drops, current levels, and read resistor values from the color coded components. ● Student will understand what constitutes a true power circuit.

Unit 1 AC/DC Circuit Configurations	
Stage 1 – Desired Results	
UNIT SUMMARY	**CORE AND SUPPLEMENTAL MATERIALS/RESOURCES (OPEN RESOURCES)**
This unit will establish the spatial/schematic relationship needed to construct an electrical circuit. What is seen in two dimensions on a circuit schematic is now represented in three dimensions on a superstrip (circuit breadboard).	1. Custom Animated Safety Manual 2. Alerich, Electricity I, Delmar Publishers 3. Alerich, Electricity II, Delmar publishers
UNDERSTANDINGS	
Students will understand that series circuits were engineered to control voltage, parallel circuits were engineered to control current, combination circuits were engineered to control power since the formula for circuit power is the product of voltage times current and tis circuit is part series and part parallel.	
Students will know…	**Students will be able to…**
Students will master circuit construction and how to perform circuit analysis using Ohm's Law to find, total voltage, total circuit current, total circuit resistance, total circuit power along with individual voltage drops in series circuits, individual branch currents in parallel circuits, and both voltage and current levels in the combination circuit.	*Students will be able to verify calculated measurements on paper with measured values in the circuits which have been correctly constructed using the Digital Volt Multimeter (DVM). Safe utilization of low voltage AC and DC with a clear understanding of what circuit resistance changes causes a "short circuit" or an "open circuit". The student will be able to explain the resistance continuum which explains that circuit power development can only take place in between a resistance extreme (defined as zero ohms and infinite ohms). Power development*

	cannot take place on a resistance extreme because the voltage or current component will always equal zero.

Stage 2 – Assessment Evidence

Performance Tasks:	Other Evidence **(Alternate Assessments)**:
• Students will analyze a series circuit with calculated and measured outcomes across each circuit load. • Students will analyze a parallel circuit with calculated and measured outcomes across each circuit load. • Students will analyze a combination circuit with calculated and measured outcomes.	*Students will also be given pre-connected circuits that will require they identify and be able to apply Ohm's Law to completely evaluate the static (DC) and dynamic (AC) parameters driving the circuit as true power, apparent power, and reactive power components.* *Student observation and procedural explanation*

Stage 3 – Learning Plan

1. This work is going to prepare the student for an employable challenge, "a job". These circuit configurations are the very beginnings of every circuit. They do not change. The laws which explain them, Kirchoff's Voltage Law, Kirchoff's Current Law, product over sum resistance formulas, and reciprocal resistance formulas, and the power formulas. Students will connect a 3 load series circuit, calculate total voltage, total current, total resistance, and total power. Individual voltage and current drops will be calculated and then measured using the Digital Volt Multimeter. The next two (2) circuits will be a 3-load parallel circuit and a three load combination circuit where the total voltage, current, resistance, and power will be calculated along with applied load voltages with branch currents. Student will be able to apply Ohm's law analysis to series, parallel, and combination circuits.

2. Plug in an extension cord to 110 volts with the ends frayed, exposed and "hot", I will verify to the class that the power cord is energized and then I will challenge them to explain what will happen if I touch one end of the power cord. After I touch one end of the energized cord, then I will bring in a bucket of cold tap water and ask the class what will happen if I drop the line cord into the water. After that learning moment, I put my hand in the water with the line cord and ask the students to explain. Students, by this time, are not only confused, but totally <u>hooked</u> on what is being taught and what needs to be learned.

3. Using an oscilloscope I show a graphical display of Alternating Current (AC) and Direct Current (DC). Using that information the student will identify rms and average voltage levels on the AC sine wave and peak levels of DC. The unique challenge students receive at this point is determining what value of DC will do the same amount of work in an AC circuit after the AC supply voltage has been measured.

4. Students are asked to tape a thermometer on a 10 watt resistor and connect the load to 10 volts AC. After the temperature on the DC resistor is measured, remove the AC and connect 1volt of pure level DC for 2 minutes and measure the DC load temperature, after 2 minutes increase the load voltage to 2 volts DC for 2 minutes, then 3 volts for 2 minutes, 4 volts for 2 minutes, 5 volts for 2 minutes, 6 volts for 2 minutes, 7 volts for two minutes, 8 volts for 2 minutes, 9 volts for 2 minutes, 10 volts DC for the last 2 minutes making sure you measured the temperature on the resistor after every 2 minute interval. After you've collected your data, graph your data on linear graphing paper and answer the following question: What level of AC voltage and current performs the same amount of work(as heat) in a circuit as DC voltage and current?
   <u>ANSWER: the rms integral 0.707</u>

PROGRESS MONITORING:

Student progress will be monitored through emulation.

Understanding how electrical current and water conflict.
Discussion and repetitive sequence will assist students with the mastery of skills.
Repetitive sequencing and reteaching will be used to assist students in need of additional supports.

Planned Differentiation & Interventions for Tiers I, II, III, ELL, 504s, SPED, and Gift & Talented Students
• Rethink and revise. Dig deeper into ideas at issue (through the faces of understanding). Revise, rehearse, and refine, as needed. Guide students in self-assessment and self-adjustment, based on feedback from inquiry, results, and discussion. ***Listed below.*** *• Evaluate understandings. Reveal what has been understood through final performances and products. Involve students in a final self-assessment to identify remaining questions, set future goals, and point toward new units and lessons.* ***Listed below.*** *•Tailor (personalize) the work to ensure maximum interest and achievement. Differentiate the approaches used and provide sufficient options and variety (without compromising goals) to make it most likely that all students will be engaged and effective.* ***Listed below.***
Gifted & Talented: Gifted and talented students are mathematically inclined which tells me they can read the following number: 6,286,000,000,000,000,000 as 6 quintillion, 2 hundred eighty-six quadrillion electrons per second will make a 1 amp current flow. Additional advanced quantities that determine amperage and voltage levels will be assigned to students who advance beyond the baseline activities.
Tier I: Will get additional information that explains why short circuits do not occur when an energized line cord is placed in a container of water. They will get the chemical analysis which shows why pure water and electricity do not react but water containing a high number of minerals will react electrically with that water content.
Tier II: These students will get a modified lesson of how mixing water with minerals (calcium, potassium, salt, etc.) makes water electrically conductive. Other modification to lessons throughout the unit will be made to support struggling students. Written directions and examples will be shared with students. Modeling and demonstrations will be done.
Tier III: Demonstrate how the chemistry of water has always been taught to be conductive because the water containing minerals has a very low resistance because of the chemical bonds formed with the mineral. Provide the class with other supplemental materials to reinforce introductory concepts of circuit configuration.
ELL: Printouts and oral and video supports will be used. Modeling of different content will be used to enable students to emulate the concepts being taught.
504s: Teach the concepts with video and other visual and auditory supports.
SPED: Reteach the danger of different water mixes and why they conduct electricity. Provide additional time, supplemental material and breakdown content as needed for these students.

Unit 2: Passive and Active Components

Content & Practice Standards	Interdisciplinary Standards for ELA Practice	Critical Knowledge & Skills
Passive and Active Components ● 9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces ● 9.3.ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy. ● 9.3.ST.5 Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways. ● 9.3.ST-ET.2 Display and communicate STEM information.	● RST.9-10.1Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. ● RST.9-10.2 determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. ● WHST.9-10.1 Write arguments focused on discipline-specific content.	● Student will learn how to identify a true power circuit, apparent power circuit, and a reactive power circuit. ● Student will understand why inductance produces no true power values in watts. Inductance will respond to DC uniquely and AC uniquely. ● Student will understand why capacitance produces no true power in watts. Capacitance will respond to DC uniquely and AC uniquely. ● Student will understand that circuit impedance is the result of resistance and reactance. ● Circuit impedance always has a circuit phase angle. Phase angles can be leading or lagging creating a leading or lagging power factor which requires correction in power circuits.

Unit 2 Passive and Active Components	
Stage 1 – Desired Results	
UNIT SUMMARY	**CORE AND SUPPLEMENTAL MATERIALS/RESOURCES (OPEN RESOURCES)**
This unit is designed to create a practical understanding of how reactive components affect the ability of a circuit to produce true power and prevent surge currents which cannot drive a load because voltage and current move at different times through the circuit. Reactive or capacitive power factors have to be corrected to prevent surge currents that do no work (as wattage) in a circuit. Power factor readings are taken with power factor meters across power lines supplying power to a circuit or to a building. Leading power factors are corrected with capacitors, lagging power factors are corrected with inductors.	**1.** Alerich, Electricity III, Delmar Publishers **2.** John Wiles, Photovoltaic Power Systems, Delmar Publishers **3.** Harris, Digital Telephone System, Delmar Publishers **4.** Schultz, Transformers and Motors, Delmar Publishers
UNDERSTANDINGS	
Students will understand that… Circuit resistance is the only component that generate true power. Inductance, being the ability of a coil to oppose changes in current flow will react one way to DC and different way to AC. The way inductance reacts to AC is called the Inductive Reactance (XL). Capacitance, being the ability of a capacitor to oppose changes in voltage will react one way to DC and a very different way to AC. The way capacitance reacts to AC is called capacitive reactance (XC).	
Students will know…	**Students will be able to…**

Students must master the calculation of inductive reactance and understand the difference between AC resistance and DC resistance. Student must also understand how to calculate or measure circuit inductance. Students must master the calculation of capacitive reactance and understand the difference between AC resistance and DC resistance. Student must also understand how to calculate or measure circuit capacitance.	***1.*** Calculate inductive reactance and show the relationship to changing frequencies. ***2.*** Calculate capacitive reactance and show the relationship to changing frequencies. ***3.*** Cross-reference inductive reactance and capacitive reactance and show how the two reactive components react to changes in frequencies**.**

Stage 2 – Assessment Evidence

Performance Tasks: ● Student will learn how to identify a true power circuit, apparent power circuit, and a reactive power circuit. ● Student will understand why inductance produces no true power values in watts. Inductance will respond to DC and AC uniquely. ● Student will understand why capacitance produces no true power in watts. Capacitance will respond to DC uniquely and AC uniquely. ● Student will understand that circuit impedance is the result of resistance and reactance.		Other Evidence **(Alternate Assessments)**: Student should be able to measure and calculate the AC resistance and the DC resistance of a coil. Student should be able to measure and calculate the AC resistance and the DC resistance of a capacitor. Graphing or analyzing collected data about these two passive components will a very interesting relationship to changing frequencies.

Stage 3 - Learning Plan

1. This student work will be vital in the design and development of circuits used in aeronautics to maintain thrust, weight, lift, and drag. Aeronautics is the science of flying aircraft while aerodynamics is the study of high aircraft moves through an air medium. Electronic systems aboard aircraft are highly sophisticated with many computer systems processing input and output data needed to keep aircraft flying safely in the air. The final performance obligations will take place when the student attempts to design a small control system that gets integrated onto a small aircraft and can communicate with the commanding officer or the first officer. Harnessed reactive energy has practical uses in signaling circuits when the time constant is adjusted for the true power component.

2. The circuit designs will be required to provide parameters needed to keep the aircraft in the air and possibly notify the pilots that problems during in-flight operations are threatening the safety of the occupants in the aircraft. Students are going to be judged for their ability to design and integrate the circuit onto a model aircraft or allow the circuit to communicate with on-board diagnostics.

3. When you think of why the atmosphere has limitation remember the following Q & A. "Why is aircraft flight usually limited to four layers of the atmosphere?" Answer: Because air in the lower layer of the exosphere is simply too thin to create lift on the wings.

4. Have you ever wondered what differences exist between a glider and an airplane? A glider is a special kind of aircraft that has no engine. There are many different types of gliders. Paper gliders are the simplest gliders to build and fly. Balsa wood or styrofoam toy gliders are an inexpensive vehicle for students to have fun with, while learning the basics of aerodynamics.

5. Using your current skill with passive components show how the energy from a pulsing inductive coil can be used to series aid a pulsing battery voltage to drive the flashing fuselage light for departures and arrivals. Take a coil with a 9 volt battery and flash neon lamp (NE70) requiring 70 volts to ionize. Using a battery powered capacitor circuit to create the same effect with an RC timing (50 uf cap x 10,000 ohm resistance times 5) circuit to illuminate the rear of an airplane fuselage.

6. Once the students are able to drive a flashing fuselage beacon with energy taken from the magnetic field of a coil and the electrostatic energy of a capacitor. Questions as to why and how these components operate lamps when they were understood not to produce any form of true power will now challenge previous information. Here is how the answer emerges. Inductors do not produce true power but they do store electromagnetic energy in their magnetic fields. Capacitors do not produce true power but they will store electrostatic energy as a surface charge. When you understand how to harness this energy with resistance values that will compromise reactive power with true power and produce what's called "apparent power". Apparent power has enough voltage and current working at the same time in a AC circuit to drive a resistive load. This same effect can be simulated in a DC circuit. The energy level in the coil circuit is much higher than the energy in the capacitor circuit, which means the inductive circuit can be used to drive higher voltage lamps compared to lower voltage signals in the capacitor circuit.

PROGRESS MONITORING

By their ability to design and test a circuit that requires critical thinking.

Students may find confusion in the way they understand different types of power levels (true,apparent, and reactive).

Special demo circuit will be available for review to remove conflicts trying to understand different types of power levels.

Students need to know how to utilize raw energy to perform tasks where the energy components work collectively to produce magnetic (inductance) or electrostatic effects (capacitance).

Planned Differentiation & Interventions for Tiers I, II, III, ELL, 504s, SPED, and Gift & Talented Students

• Rethink and revise. Dig deeper into ideas at issue (through the faces of understanding). Revise, rehearse, and refine, as needed. Guide students in self-assessment and self-adjustment, based on feedback from inquiry, results, and discussion. ***Listed Below***.

• Evaluate understandings. Reveal what has been understood through final performances and products. Involve students in a final self-assessment to identify remaining questions, set future goals, and point toward new units and lessons. ***Listed Below***.

•Tailor (personalize) the work to ensure maximum interest and achievement. Differentiate the approaches used and provide sufficient options and variety (without compromising goals) to make it most likely that all students will be engaged and effective. ***Listed Below.***

Gifted & Talented:

These students will be able to calculate the amount of energy (in joules) that an inductor operating in series with a resistor is able to produce. That level of raw energy is converted into a wattage to determine which electrical loads the circuit is capable of driving. These calculations will be verified with various test procedures. The energy levels needed are controlled by the resistance values working in the inductance/capacitance circuits.

Tier I: These students will calculate the inductive resistive timing that could be used to drive a flashing beacon. The five period calculation time will be verified by formula, operated under load and viewed as a performance competency on the oscilloscope. These same students will calculate the capacitive resistive timing on a capacitor and verify the five periods of the time constant on the oscilloscope and then test under load.
Tier II: These students will receive a modified lesson and view it on the oscilloscope. The coil circuit will show the energy existing tin the magnetic field when the current through the coil is interrupted Calculations will not be required but the circuits ability to produce a flashing beacon, inductively and capacitively coupled will be required.
Tier III: This student group will be asked to construct the circuit that manually flashes a neon lamp or an LED "on" an "off" to sustain what might be considered a visual beacon. These circuit will be prewired to facilitate understanding the result viewed.
ELL: ELL students will receive assistance from a printed lesson where color explanations are provided to the procedures before the circuit operates. This lesson allows them to see what components have been connected and how the magnetic field or surface charged electrostatic field is channeling energy into the load.
504s: These students will evaluate a working circuit to determine the type of reactive energy being released into the incandescent lamp or the LED. These students will be given additional time to view the circuit operation and then take note of how the circuit functions.
SPED: These students will view a video that drives a flashing beacon with resistive-reactive energy. The student that needs remediation will be able to review the view the video presentation as often as is needed. A basic word vocabulary will be included to assist in the comprehension of the lesson.

<table>
<tr><th colspan="3">Unit 3: Digital Circuit Design</th></tr>
<tr><th>Content & Practice Standards</th><th>Interdisciplinary Standards for ELA Practice</th><th>Critical Knowledge & Skills</th></tr>
<tr><td><u>Digital Circuit Design</u>
● 9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces
● 9.3.ST.4 Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.
● 9.3.ST.5 Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.
● 9.3.ST-ET.2 Display and communicate STEM information.
● 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.
● 9.3.MN-PRO.5 Demonstrate the safe use of manufacturing equipment.
● 9.3.MN-QAO.5 Perform safety inspections and training to ensure a safe and healthy workplace.
● 9.3.ST-ET.1 Use STEM concepts and processes to solve problems involving design and/or production.
● 9.3.ST-ET.2 Display and communicate STEM information.
● 9.3.ST-ET.3 Apply processes and concepts for the use of technological tools in STEM.
● 9.3.ST-ET.4 Apply the elements of the design process.
● 9.3.ST-ET.5 Apply the knowledge learned in STEM to solve problems.
● 9.3.ST-ET.6 Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.</td><td>● RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
● RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context
● WHST.9-10.1 Write arguments focused on discipline-specific content.</td><td>● Student will take a stated word problem and convert the problem into a math equation.
● Student will convert the word problem into hardware to perform control logic stipulated in the parameters of the original design word problem.
● Student will use relevant laws of algebra to simplify the original equation into a simpler equation.
● The simple equation will be converted into control logic hardware that has identical control logic parameters found in the original equation.
● The hardware in the original equation and the simple equation will be compared to identify any inconsistencies in the logic.
● The number of input variables and input sequences along with the maximum count will be evaluated with a hardware analysis that gives specific counts of logic circuits and inverters that will be used to establish the design.
● The simple circuit equation will be converted into hardware and tested against the parameters of the design.
● The simple circuit data will be compared to the original circuit data. Once the two circuits (original and simple) have valid and identical data, student will decide the type of logic family to implement the design.
● Student will be able to fabricate and test the simple circuit.
● Circuit will be integrated onto a computing platform to communicate with an on-board small aviation system.</td></tr>
<tr><th colspan="3">Unit 3: Digital Circuit Design</th></tr>
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Stage 1 – Desired Results

Unit Summary	Core and Supplemental Materials/Resources (open resources)
Students move into the most interesting phase of circuit design where a stated word problem gets integrated onto a microprocessor which is controlled by a high level computer language. Students learn how to check their circuit designs by converting equation results into a minterm or maxterm form, while applying simplifications that yield identical results from a strategic mapping alignment.	1. Vahid, Digital Design, Delmar Publishers 2. Alam & Alam, Digital Logic Design, Delmar Publishers 3. Platt, Electronics, Delmar Publishers 4. Tybal, Electronic Circuit Design MCQ's (Most frequently Asked Questions), Delmar Publishers 5. Kleitz, Digital Electronics, Delmar Publishers

Understandings

Students will understand that…

6. Electronic Circuit Design is a STEM skill that utilizes science, technology, engineering and math to creatively design circuits that have capabilities to amaze and control circuits that switch power levels "on an off" when specific parameters are met in the world of controlled energy.
7. Electronic Circuit Designs can improve the way of life for all people throughout the world, not just in a small country.

Students will know…	**Students will be able to…**
What content will be covered that students must master? Students must master the ability to retrieve math equations from word problems having complex arrangements yielding design parameters.	Students need to be able to do Level 1 designs to be proficient at integrating a small system design into a much larger design that enhances the small system performance. An example of this would be to design a digital stepping circuit that will be used to indicate the volume on a satellite radio system as a numerical digital component instead of using an analog dial. The numerical volume level will also indicate the decibel level of the audio.

Stage 2 – Assessment Evidence

Performance Tasks:	Other Evidence **(Alternate Assessments)**:
• Student will take a stated word problem and convert the problem into a math equation. • Student will convert the word problem into hardware to perform control logic stipulated in the parameters of the original design word problem. • Student will use relevant laws of algebra to simplify the original equation into a simpler equation. • The number of input variables and input sequences along with the maximum count will be evaluated with a hardware analysis that gives specific counts of logic circuits and inverters that will be used to establish the design. • The simple equation will be converted into control logic hardware that has identical control logic parameters found in the original equation.	Not all students will be able to do Level 1 designs. Some will only complete partial designs or improvements to existing circuits identified as digital or analog.

● The simple circuit data will be compared to the original circuit data. Once the two circuits (original and simple) have valid and identical data, student will decide the type of logic family to implement the design. ● Student will be able to fabricate and test the simple circuit. ● Circuit will be integrated onto a computing platform to communicate with an on-board small aviation system.	

Stage 3 – Learning Plan

The learning curve being explored will eventually take the student into a level of circuit design that motivates the student to grow into a confident circuit designer with skills that many students would like to improve upon. The next level of circuit design will require more math talent. This level is called De Morganization Theory where students simplify the more 2nd and 3rd level of logic in order to bring the equations back to boolean level where FMCC rules apply. The student needs to keep in mind that the math is probably your most important vehicle in design, because an experienced designer will be able to see the total design picture before hardware implementation. When students complete a total design, test the logic and verify valid parameters you have a energy designer ready for the "global markets".

The student who reads a 2nd and 3rd level of logic, understands how to apply the rules of DeMorganization, which are complementing all the inputs on a visualized equation, then complement all the visual outputs on an equation, followed by a reduction of identical hardware and a changing of logic signs; anding becomes or while oring becomes and. Demorganization gives you design criteria which allows you to check the validity of your design equations by converting the equations into minterm or maxterm form. Depending on the number of variables the equation can be deciphered into numerical quantities and placed on a strategic map for additional simplification. This is an outstanding feature of knowing how to DeMorganize.

3. I do believe the general consensus to be these design methods are current being used (probably as a software tool) but becomes the norm for preparing student to learn Electrical Engineering Technology.
4. The organization and effective sequence for learning is uniquely compromised with color infused animated lessons. Lesson samples are producing results.

5. Students will complete a general knowledge exam.

PROGRESS MONITORING:

Student progress will be monitored through emulation.
Understanding how electrical current and water conflict.
Discussion and repetitive sequence will assist students with the mastery of skills.
Repetitive sequencing and reteaching will be used to assist students in need of additional supports.

Planned Differentiation & Interventions for Tiers I, II, III, ELL, 504s, SPED, and Gift & Talented Students

• *Rethink and revise. Dig deeper into ideas at issue (through the faces of understanding). Revise, rehearse, and refine, as needed. Guide students in self-assessment and self-adjustment, based on feedback from inquiry, results, and discussion.* ***Listed below.***

• *Evaluate understandings. Reveal what has been understood through final performances and products. Involve students in a final self-assessment to identify remaining questions, set future goals, and point toward new units and lessons.* ***Listed below.***

•*Tailor (personalize) the work to ensure maximum interest and achievement. Differentiate the approaches used and provide sufficient options and variety (without compromising goals) to make it most likely that all students will be engaged and effective.* **Listed below.**
Gifted & Talented: G & T Students will advance into DeMorganization to complete more advanced levels of circuit design. Other advanced topics in this area will be presented to the students.
Tier I: These students will design and showcase their circuit for the annual EHT Pride Day. Students will be given advanced circuit design challenges and multi-step problems to solve.
Tier II: These students will receive modified instruction additional support material will be provided to give the students additional practice exercise.
Tier III: These students will receive printed lessons. The material will be presented in multiple formats and a demonstration of how to solve the problems in alternative ways will be modeled for the students.
ELL: I will remediate by used auditory and visual supports. Google translate and breaking down the content will be done. Repeating instructions and modeling will be used throughout the class.
504s: These students will view video content to support the learning curves of these students. Additional strategies as highlighted in the implementation document will be used.
SPED: Students who have difficulty completing level 3 designs will complete electronic kits and then discuss the “how” and “why” of the design. Other modifications to student activities and assignments will be made as indicated on the IEP.

Unit 4: Small System Prototype Design		
Content & Practice Standards	**Interdisciplinary Standards for ELA Practice**	**Critical Knowledge & Skills**
Small System Prototype Design ● 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society. ● 9.3.ST-SM.4 Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data. ● 9.3.ST-ET.5 Apply the knowledge learned in STEM to solve problems. ● 9.3.ST-ET.2 Display and communicate STEM information. . ● 9.3.ST.6 Demonstrate technical skills needed in a chosen STEM field.	● 9.3.ST.1 Apply engineering skills in a project that requires project management, process control and quality assurance. ● 9.3.ST.2 Use technology to acquire, manipulate, analyze and report data. ● 9.3.ST.3 Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.	● The student will be able to install a lift transducer and direct measurement of stall margin rather than complicated derived calculation which varies with the weight of the aircraft, load factor, center of gravity etc. ● The student will be able to install circuit that measures drag. Drag is the aerodynamic force that opposes an aircraft's motion through the air. Drag is generated by every part of the airplane (even the engines!). ● The student will be able to install a thin-film force sensor (FlexiForce A301) integrated to the motor mount in order to measure the thrust force during the flight. ● The student will be able to install a weight sensor on the aircraft to monitor needed thrust during take-off.

Unit 4: Small System Prototype Design	
Stage 1 – Desired Results	
UNIT SUMMARY	**CORE AND SUPPLEMENTAL MATERIALS/RESOURCES (OPEN RESOURCES)**
Brief 2-4 sentence description of unit purpose, what is covered, and what students will understand at the conclusion of the unit. 1. In this unit the students will construct a remotely controlled aircraft with sensors to monitor thrust, weight, drag, and lift. 2. In this unit the student will be able to install sensors that monitor critical forces needed to keep an aircraft in flight.	MegaHobby.com has many model jet aircraft. MegaHobby.com also stocks many great aircraft update and detail sets in our aircraft and updates section to help make your model airplane a real show winner! If you are building a model aircraft diorama scene, be sure to check out the diorama details section for ground crew, pilot figures, diorama bases, and airfield and vehicles.
UNDERSTANDINGS	
Students will understand that… The successful completion of this model aircraft will have the following parameters for assessment: 1. SAFE DEPARTURES 2. BANK AND ROLL TECHNIQUE. It's important to complete the assessment in a systematic fashion; that is made easier through a checklist. 3. NAMING AIRPLANE PARTS	

4. USING FLIGHT COMPASS
5. WIDE RADIUS CIRCLING
6. MINIMIZED NOISE POLLUTION... get advice from someone whSAo is competent in noise assessment.

Students will know…	**Students will be able to…**
What content will be covered that students must master? ***Mechanical Assembly and Electronic Circuit Assembly***	*What should students be able to accomplish to demonstrate understanding?* ***Each section of the aircraft should be assembled on a schedule to minimize problems.***

Stage 2 – Assessment Evidence

Performance Tasks:

- The student will be able to install a lift transducer and direct measurement of stall margin rather than complicated derived calculation which varies with the weight of the aircraft, load factor, center of gravity etc.
- The student will be able to install circuit that measures drag. Drag is the aerodynamic force that opposes an aircraft's motion through the air. Drag is generated by every part of the airplane (even the engines!).
- The student will be able to install a thin-film force sensor (FlexiForce A301) integrated to the motor mount in order to measure the thrust force during the flight.
- The student will be able to install a weight sensor on the aircraft to monitor needed thrust during take-off**.**

Other Evidence **(Alternate Assessments)**:
What other means of assessment will be used throughout this unit?

Students will be graded on their ability to assemble:

1. Winglets
2. Horizontal Stabilizer
3. Vertical Stabilizer
4. Rudder
5. Elevator
6. Flaps
7. Aileron
8. Spoilers
9. Slats
10. Fuselage
11. Cockpit
12. Turbine Engine
13. **Wings**

Stage 3 – Learning Plan

1. The end result of this work is to have the student complete a major project that becomes a part of their skill development skill.

2. Each student will participate in a model aircraft competition that identifies best design practices.

3. The aircraft competition will judge each ground pilot on their ability to do three basic maneuvers:

1. Aircraft departure with bank and role.
2. Reading information transmitted to the model aircraft
3. Trouble free landing with simulated reverse thrust.

4. Organization and sequencing the learning formats will emerge the students ability to implement directions needed to assemble the aircraft.

PROGRESS MONITORING::

Student progress will be monitored through modeling and observation
Direct students to follow along and work on respective tasks in sequence
Discussion, repetitive sequence, observation, and feedback will assist students with the mastery of skills.
Repetitive sequencing and reteaching will be used to assist students in need of additional supports.

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• Rethink and revise. Dig deeper into ideas at issue (through the faces of understanding). Revise, rehearse, and refine, as needed. Guide students in self-assessment and self-adjustment, based on feedback from inquiry, results, and discussion. ***The winner of the final aircraft assessment will be crowned BEST EHT MODEL AIRCRAFT GROUND PILOT!***

• Evaluate understandings. Reveal what has been understood through final performances and products. Involve students in a final self-assessment to identify remaining questions, set future goals, and point toward new units and lessons. Listed below. ***Listed below.***

•Tailor (personalize) the work to ensure maximum interest and achievement. Differentiate the approaches used and provide sufficient options and variety (without compromising goals) to make it most likely that all students will be engaged and effective. ***Listed below.***

Gifted & Talented:
These students will compete with students in this category. The winner will advance to the finals with aTier I winner, Tier II winner, Tier III winner, ELL winner, 504 winner, and the SPED winner.

Tier I:
These students will compete with students in this category. The winner will advance to the finals with aTier I winner, Tier II winner, Tier III winner, ELL winner, 504 winner, and the SPED winner.

Tier II:
These students will compete with students in this category. The winner will advance to the finals with aTier I winner, Tier II winner, Tier III winner, ELL winner, 504 winner, and the SPED winner.

Tier III:
These students will compete with students in this category. The winner will advance to the finals with aTier I winner, Tier II winner, Tier III winner, ELL winner, 504 winner, and the SPED winner.

ELL: These students will compete with students in this category. The winner will advance to the finals with aTier I winner, Tier II winner, Tier III winner, ELL winner, 504 winner, and the SPED winner. I will remediate by used auditory and visual supports. Google translate and breaking down the content will be done. Repeating instructions and modeling will be used throughout the class.
504s: These students will compete with students in this category. The winner will advance to the finals with aTier I winner, Tier II winner, Tier III winner, ELL winner, 504 winner, and the SPED winner. These students will evaluate a working circuit to determine the type of reactive energy being released into the incandescent lamp or the LED. These students will be given additional time to view the circuit operation and then take note of how the circuit functions.
SPED: These students will compete with students in this category. The winner will advance to the finals with aTier I winner, Tier II winner, Tier III winner, ELL winner, 504 winner, and the SPED winner. Activities will be modified as determined in their IEP. Examples include peer coaching, repeated instructions, and written directions. Students who have difficulty completing level 3 designs will complete electronic kits and then discuss the “how” and “why” of the design. Other modifications to student activities and assignments will be made as indicated on the IEP.