Career and Technical Education (CTE)

Robotics and Engineering

BOARD APPROVAL DATE: 8/17/2021

BOARD ADOPTION OF STATE STANDARDS: 9/1/2022

Unit Overview (Standards Coverage)				
Unit	**Standards**	**Unit Focus**	**Skills Overview**	**Suggested Pacing**
Unit 1	• **8.1.12.CS.2: Model interactions between application software, system software, and hardware.** • **8.1.12.DA.4: Explain the relationship between binary numbers and the storage and use of data in a computing device.**	**Circuitry and Microcontrollers**	• **Wiring** • **Multimeter Usage** • **Block Coding**	**8-10 weeks**
Unit 2	• **8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.** • **8.1.12.CS.2: Model interactions between application software, system software, and hardware.**	**Robotics Programming**	• **Written Coding** • **Spacial Control** • **Component Usage**	**12-14 weeks**
Unit 3	• **8.2.12.NT.2: Redesign an existing product to improve form or function.** • **8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.**	**Robotics Design**	• **Kinematics** • **Gear Ratios** • **Strength of Materials**	**8-10 weeks**
Unit 4	• **8.2.12.ED.3: Evaluate several models of the same type of product and make**	**Quadcopter Programming**	• **Aviation Forces** • **Flight Controls** • **Flight Coding**	**4-6 weeks**

	recommendations for a new design based on a cost benefit analysis. ● **8.1.12.CS.3: Compare the functions of application software, system software, and hardware.**			

This document outlines in detail the answers to 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: Circuitry and Microcontrollers		
Content & Practice Standards (write in full)	**Suggested Standards for Practice**	**Critical Knowledge & Skills**
• **8.1.12.CS.2: Model interactions between application software, system software, and hardware.** • **8.1.12.DA.4: Explain the relationship between binary numbers and the storage and use of data in a computing device.**	• **9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).** • **9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).**	• **Wiring** • **Multimeter Usage** • **Block Coding**

Unit 1: Circuitry and Microcontrollers

Stage 1 – Desired Results

Unit Summary	Core and Supplemental Materials/Resources (open resources)
Unit 1 will cover Circuitry and Microcontrollers. Students will begin with learning how to set up a simple Series LED circuit and how breadboards work. At the end of the unit, they will be able to create complex circuits and program an Arduino microcontroller to control electrical current.	• TinkerCAD software • Arduino kits • Teacher-supplied instructions • Online tutorials • 3D printers

Understandings

Resistors are used to control the amount of current flowing through a circuit.
Sensors observe information from the environment and communicate this information to the microcontroller.
Programming allows the user to control when and how much current is applied to the circuit.

Students will know…	Students will be able to…
Students will know how to wire circuits with resistors, variable resistors, sensors, and motors.	Students will be able to recreate circuit schematics and code effective programs to complete the given objective.

Stage 2 – Assessment Evidence

Performance Tasks:	Other Evidence **(Alternate Assessments)**:
Students will create circuits using the proper components either in Series or Parallel. Students will measure voltages and currents using Multimeters to ensure proper power is supplied to the circuit.	Group Participation Design Activities File Management

Students will code and test microcontroller programs that actuate components such as motors and sensors.	

Stage 3 – Learning Plan

Students will begin with learning simple Resistor circuits. They will learn different types of configurations and why a designer would use one versus another. They will also learn the layout of the Arduino and how to code a basic light pattern. Students will build the following circuits:

- Resistors in series
- Resistors in parallel
- Chasing LEDs programming project

Students will next learn about Variable Resistors and how they differ from traditional Resistors. They will learn how these Resistors allow for user control of a circuit. They will also learn about Digital Inputs and Analog Outputs using the Arduino Microcontrollers. Students will build the following circuits:

- Photosensitive Resistors
- Switches
- Potentiometers
- IR Sensors
- Capacitors
- Switch-Controlled LED Pulse programming project

Students will move on to Sensors that allow the designer to read information from the environment in order to trigger the Arduino to do something. They will also learn about Analog Inputs. Students will build the following circuits:

- Ultrasonic Sensors
- Potentiometer-Controller LED Array

The final section of this unit will be about Electric Motors and how they can be controlled to produce motion. Students will learn about the different types and why a designer would use one versus another. They will build the following circuits:

- Transistors
- Electric Motors
- Stepper Motors
- Electric Car Distance programming project

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.

• 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.

•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.

Gifted & Talented: Students can watch videos on how to do more advanced techniques on the software covered for this unit and refine their design activities. Alternatively, they can search for other types of software that can be used to complete their tasks.
Tier I: Students can watch videos on how to do more advanced techniques on the software covered for this unit and refine their design activities.
Tier II: Students in this tier will be given extra assistance through the use of wiring guides. These students could receive some of the pin locations to further assist in the circuitry.
Tier III: Students in this group will be retaught the lesson to focus more on the area where these students are struggling. These students could get wires placed for them with a few missing pins or components.
ELL: Students will be allowed to ask their ESL teachers for help. They will also be given any materials in their native language. Most of the materials are only numbers, however the words will be translated.
504s: Students in this group will get the modifications that are on their 504 plans such as preferential seating, extended testing, and completed guided notes. They may also be given more wires or pins than the other students.
SPED: Students in this group will get the modifications that are on their IEP plans such as preferential seating, extended testing, and completed guided notes. Their aid (if any) will also be given additional wires or pins to better assist them.

Unit 2: Robotics Programming		
Content & Practice Standards	**Suggested Standards for ELA Practice**	**Critical Knowledge & Skills**
• **8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.** • **8.1.12.CS.2: Model interactions between application software, system software, and hardware.**	• **9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).** • **9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).**	• **Written Coding** • **Spacial Control** • **Component Usage**

Unit 2: Robotics Programming

Stage 1 – Desired Results

Unit Summary	Core and Supplemental Materials/Resources (open resources)
Unit 2 will cover Robotics Programming. Students will begin by building the Vex robots and learning the basic movement commands. At the end of the unit, they will be able to program the robot to complete a complex set of commands and interact with its environment.	• Vex V5 software • Vex V5 robotics kits • Teacher-supplied instructions • Online tutorials • 3D printers

Understandings

Robots use motors and linkages to interact with and manipulate their environments.
Sensors detect changes in the environment such as incoming objects and obstacles.
Programming allows these components to be controlled in an appropriate and effective way to accomplish a given task.

Students will know…	Students will be able to…
Students will know how to program the motors and sensors of the Vex robots using the V5 software.	Students will be able to control the robots through code and by hand in order to complete a series of challenges.

Stage 2 – Assessment Evidence

Performance Tasks:	Other Evidence **(Alternate Assessments)**:
Students will navigate the robot around obstacles and through mazes. Students will manipulate objects in the environment using linkages. Students will control sensors to identify new obstacles.	Group Participation Design Activities File Management

Stage 3 – Learning Plan

Students will begin by building the Vex V5 robots. They will then be given an overview of the various components, such as the controller, battery, motors, and linkages. This information will help them identify their purpose and function. They will then learn the basic Movement commands:

- Forward/backward movement
- Turning
- Arm movement
- Claw movement

Students will next learn the Control functions and how these allow for more precise and efficient command of the robot. This will in turn lead to an understanding of properly coded commands versus "hard coding." Finally, this section teaches students about the concepts of Booleans, conditions, and variables. The Control functions learned are:

- Wait
- Repeat
- If/Else

Students will move on to Sensors that allow the designer to read information from the environment in order to trigger the Vex robot to do something. Sensors used are:

- Timer
- Touch
- Distance
- Position
- Color

The final section of this unit allows the students to design their own problems and courses. They will have the opportunity to research a potential design or start completely from scratch. Layouts include:

- Maze
- Obstacle course
- Sports arena

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.

• 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.

•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.

Gifted & Talented:
Students can watch videos on how to do more advanced techniques on the software covered for this unit and refine their coding challenges. Alternatively, they can search for other types of software that can be used to complete their tasks.

Tier I: Students can watch videos on how to do more advanced techniques on the software covered for this unit and refine their coding challenges.
Tier II: Students in this tier will be given extra assistance through the use of coding guides. These students could receive some of the blocks to further assist in the coding.
Tier III: Students in this group will be retaught the lesson to focus more on the area where these students are struggling. These students could get blocks placed for them with a few missing lines or numbers.
ELL: Students will be allowed to ask their ESL teachers for help. They will also be given any materials in their native language. Most of the materials are only numbers, however the words will be translated.
504s: Students in this group will get the modifications that are on their 504 plans such as preferential seating, extended testing, and completed guided notes. They may also be given more blocks than the other students.
SPED: Students in this group will get the modifications that are on their IEP plans such as preferential seating, extended testing, and completed guided notes. Their aid (if any) will also be given additional blocks to better assist them.

Unit 3: Robotics Design		
Content & Practice Standards	**Suggested Standards for ELA Practice**	**Critical Knowledge & Skills**
• **8.2.12.NT.2: Redesign an existing product to improve form or function.** • **8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.**	• **9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).** • **9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).**	• **Kinematics** • **Gear Ratios** • **Strength of Materials**

Unit 3: Robotics Design

Stage 1 – Desired Results

Unit Summary	Core and Supplemental Materials/Resources (open resources)
Unit 3 will cover Robotics Design. Students will begin by building the LEGO EV3 Educator Robots and learning the basic components. At the end of the unit, they will be able to completely redesign their robots to be specialized for a variety of tasks.	• LEGO Mindstorm kits • Teacher-supplied instructions • Online tutorials • 3D Printers

Understandings

Kinematics is the study of motion as it pertains to linkages.
Mechanical Design can be integrated with programming to better accomplish performance tasks.
Strength of Materials deals with the strength and rigidity of mechanical devices.

Students will know…	Students will be able to…
Students will know how to incorporate structural members, kinematic members, and motors into existing designs.	Students will be able to reverse engineer robots in order to increase performance and enable new functions.

Stage 2 – Assessment Evidence

Performance Tasks:	Other Evidence **(Alternate Assessments)**:
Students will create gear trains using the proper ratios and spacings. Students will Reverse Engineer given designs and improve their performance through testing multiple parameters.	Group Participation Design Activities File Management

Stage 3 – Learning Plan

Students will begin by building the LEGO Mindstorm EV3 Educator robots. This will give a basic understanding of the components such as structural members, kinematic members, motors, and sensors. They will also be introduced to the programming language, which is very similar to the system they learned in the Vex unit. Basic commands learned are:

- Movement
- Gate command
- Control commands
- Loops
- Conditional statements
- Sensor control

Students will next be asked to improve the performance of the Educator robot. They will learn about structural stability, gear ratios, and traction and use these concepts to increase the criteria of:

- Straight-line speed
- Payload capacity
- Lifting strength

Students will then disassemble the Educator robots and next be tasked with designing machines from scratch. They will be given a task that needs to be completed using the simplest and most effective methods. Tasks include:

- Paper airplane launcher
- Crane
- Hill climber

Students will end with a final design project which will incorporate coding and design. They will be asked to theorize a machine that could help society, such as a machine that sorts trash. They will use sensors to control the function of the robot and write the code in a way that makes it autonomous.

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.

• 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.

•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.

Gifted & Talented:
Students can watch videos on how to do more advanced techniques on the software covered for this unit and refine their design activities. Alternatively, they can search for other types of software that can be used to complete their tasks.

Tier I: Students can watch videos on how to do more advanced techniques on the software covered for this unit and refine their design activities.
Tier II: Students in this tier will be given extra assistance through the use of mate tips and guides. These students could receive some of the mates to further assist in the building of the part.
Tier III: Students in this group will be retaught the lesson to focus more on the area where these students are struggling. These students could get parts mated for them with a few missing parts or constraints.
ELL: Students will be allowed to ask their ESL teachers for help. They will also be given any materials in their native language. Most of the materials are only numbers, however the words will be translated.
504s: Students in this group will get the modifications that are on their 504 plans such as preferential seating, extended testing, and completed guided notes. They may also be given more mates or views than the other students.
SPED: Students in this group will get the modifications that are on their IEP plans such as preferential seating, extended testing, and completed guided notes. Their aid (if any) will also be given additional mates or views to better assist them.

Unit 4: Quadcopter Programming		
Content & Practice Standards	**Suggested Standards for ELA Practice**	**Critical Knowledge & Skills**
• **8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.** • **8.1.12.CS.3: Compare the functions of application software, system software, and hardware.**	• **9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).** • **9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).**	• **Aviation Forces** • **Flight Controls** • **Flight Coding**

Unit 4: Quadcopter Programming

Stage 1 – Desired Results

Unit Summary	Core and Supplemental Materials/Resources (open resources)
Unit 4 will cover Quadcopter Programming. Students will begin by learning about the various constraints placed on aircraft by the forces in the air. At the end of the unit, they will program the quadcopters to complete a series of complex flight maneuvers.	• Tello drones • Teacher-supplied instructions • Online tutorials • 3D printers

Understandings

Aircraft are subjected to the forces of lift, weight, drag, and thrust.
Quadcopters use the control of four motors to apply both lift and thrust.
Quadcopters can be programmed to selectively actuate motors to complete movement patterns.

Students will know…	Students will be able to…
Students will know how to control a small quadcopter using both coding and manual control.	Students will be able to complete complex movements and objectives using Tello drones.

Stage 2 – Assessment Evidence

Performance Tasks:	Other Evidence **(Alternate Assessments)**:
Students will balance a quadcopter manually in order to maintain level flight. Students will program motors to apply force in the vertical and horizontal directions. Students will operate a quadcopter manually to navigate a course.	Group Participation Design Activities File Management

Stage 3 – Learning Plan

Students will begin by learning about the concepts of flight and the forces associated with it. They will learn about different types of aircraft and how these systems work differently. Topics include:

- Lift
- Weight
- Drag
- Thrust
- Pitch
- Roll
- Yaw

Students will then be introduced to the quadcopters. They will begin with the larger flyers that are controlled by remote control. They will learn about the controls and how to balance them to achieve level flight. They will then run a series of courses that will test their capabilities. Courses include:

- Obstacle course
- Ring course
- Payload course

The final unit will conclude with using the Tello drones. These quadcopters are programmable and thus can be used as a final platform to learn about autonomous control. Students will learn the basic movement commands of:

- Takeoff
- Landing
- Forward/backward movement
- Turning
- Flipping

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

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• 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.

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