* Unit 1: Computer Programming *

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.5	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
CS.9-12.8.2.12.NT.1	Explain how different groups can contribute to the overall design of a product.

Transfer Goals

Develop proficiency with Python lanugage and associated programming concepts such data types, conditional statements, iterative execution, program control, expression evaluation, functions, classes and objects, libraries, and testing and debugging required to perform computational problem solving for associated robotics problems.

Life Literacies and Key Skills

Develop proficiency with Python lanugage and associated programming concepts such data types, conditional statements, iterative execution, program control, expression evaluation, functions, classes and objects, libraries, and testing and debugging required to perform computational problem solving for associated robotics problems.

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.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).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- How are expressions evaluated in python?
- How can a conditional statement like "if, then, else "be useful for program branching?
- How do I design my program for testing?
- Why is a library useful and how do I import it into my program?
- How and why do I associate functions with a class definition?
- How can I get user input, strings or numbers in my application?
- How can prints be used as a debugging tool?

- How does program control occur through main(), statements and functions?
- How specific should my function be?
- Regarding iteration, what's the difference between for loops and while loops?
- When should code be written as a function?
- Why do I need to understand the difference between signed and unsigned integers, strings, characters and floats for my application?
- Why is a class useful?

Understandings

Students will understand that:

- Debugging a program is not straightforward because hardware issues result in poor performance and not necessarily an error.
- Programming a solution requires designing an algorithm that is workable with the used programming language.
- Programming an engineering solution requires knowledge of the programming language and IDE as well as the hardware devices (eg. sensors) the program is interacting with.
- Programming is a creative design process that is a fundamental skill required by all STEM practitioners.
- Solving simple problems (code and test) and incorporating the code in a final design is preferable to writing code for one large program and debugging it can be inefficient.
- Typically, the more a programmer is familiar with the programming language capabilities, the more programimng options are available.

Critical Knowledge and Skills

Knowledge

Students will know:

- The different data types in python -boolean, integer, character, string, float, unsigned and signed int..
- The difference between "if then else" and "if then elif and else"
- How to construct a for loop() and a while Loop()
- How control passes to and returns from a for loop
- How control passes to and returns from a function call.
- How to use parenthesis to force expression evaluation?
- When a global variable might make sense.
- When to use a nested for loop.
- The syntax of creating a function along with passing parameters.

- The use and placement of break, continue
- Understand the definition of an object.

Skills

Students will be able to:

- Use appropriate data types in a program.
- Use conditional statements where appropriate.
- Use iterative statements where appropriate.
- Understand program control so that one can build and debug an algorithm.
- Write complicated expressions with the rules of expression evaluation for python in mind.
- Know how to construct a function in python with parameters and a return "value".
- Knowing what parts of a program can be replaced with a function not only for repetition but program readability and debugging.
- How to use and create library functions for a class.
- What strategies are useful for debugging and testing code?
- Put comments in code.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

A project that requires students to demonstate their understanding of algorithm design, conditional statements, program control, functions, looping (While & For) and LocoExtremes LED Light ring. See Related Documents for trace_rectangle() in FunctionAssignment.docx and LightWaveProject.docx .

Quiz on LocoRobo's LED array lights, namely how to change the value using a hexadecimal number.

Primary Resources

- LocoRobo Academy Coding Environment
- The Python3 Standard Library from Anaconda
- Sublime Text Editor

Supplementary Resources

- *Think Python: How to Think Like a Computer Scientist, 2nd ed.*

  https://greenteapress.com/thinkpython2/thinkpython2.pdf

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
  - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
  - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.
- **One to One Student's laptop**
  - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❏ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❏ All assignments have been created in the student’s native language.

❏ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❏ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❏ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - A program can be represented by a flow chart so that the control flow and number of iterations can be checked on paper befor commiting to code.

SCIENCE - An algorithm is best designed on paper before being coded.

SOCIAL STUDIES - The history of these programming constructs in computer science can be examined, namely what were the circumstances for their creation?

WORLD LANGUAGES - Use correct syntax and tab formatting in Python propgrams. Learn to refer to the dictionary of Python online at the standard Python3 designation.

VISUAL/PERFORMING ARTS - Students can act out an iterative construct.

BUSINESS EDUCATION - Students will realize that debugging a poorly designed program is often not productive from a business sense, it might be cheaper to simply redesign it.

GLOBAL AWARENESS - Students will realize the names of functions may have a cultural bent depending upon the frame of reference of the programmers from their native country.

Learning Plan / Pacing Guide

Week 1:

Use LocoRobo Gui to program the robot to move in a rectangle or square

Introduce Repeat Command (For Loop)

Hex Color Wheel (decimal, binary, octal, and hex nymbering systems)

Week 2:

Identify Locationof Led#0 on the LED Array,

Create white, red, green, black, yellow, or orange array

Work on Light Wave Assignment

Week 3:

Practice Binary and Hexadecimal conversions. Assign Hwk.

Convert GUI program to python, Best Practice for Code Writing

For Loops

Conditional Decisions #1: If/Else Conditions

Week 4:

Conditional Decisions #2 If/Else Conditions in a Loop

Conditional Decisions #3: Logical Operators

Conditional Decsions #4: While Loops

Nested Loops.

Python Math and The Print Function

Week 5:

Project (see Summative Assessment)

* Unit 2: Drone Technology *

Content Area:	**Applied Tech**
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CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
	If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.
	Newton's second law accurately predicts changes in the motion of macroscopic objects.
	Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.

Transfer Goals

Students will use the drone's roll, pitch, and thrust to accomplish a task like landing on a bulls eye or flying a prescribed course. To accomplish this goal, students need to: understand the fundamentals physics of drone flight, calibrate their drone, and understand the limits of calibration and drone software. The students python programming skill set will expand in the process. Students will learn how to repair their drone, if possible.

Life Literacies and Key Skills

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
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TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- How does the physics of torque and angular acceleration explain how the drone can flow forward, backwards, left, right or rotate?
- What software do I need to write to calibrate my drone or travel a prescribed flight course?
- How do I break up my projects into manageable and testable sub-projects?

- Can I get my drone to fly to a specific height?
- Why doesn't my drone hover in place?
- How does battery energy affect drone performance(roll, pitch, and throttle)?
- Why can't the Aura's drone yaw be controlled?
- What software needs to be written to abort flying when a toggle button is pressed?
- What steps are taken when my drone does not bind to the software?

Understandings

Students need to understand the physics of drone flight and the difficulty of reliably controlling a flying device with four motors. The drone hardware and arduino interface are fixed. The student needs to accomplish tasks by using python software control.

Pitch, roll and throtlle are available parameters to control. Once the drone is successfuly trimmed, drone flying challenges can be accomplished. Of course, battery voltage, drone's cage and motor shaft all play a roll in affecting the drone's flight no matter

the software. However, even with initial trimming, the longer the drone flies the more drift errors can accumulate thus reducing stability despite the trim values. Initially finding trim values also will not address issues of external forces causing the drone to move.

This results in this type of drone being limited in its ability to execute a series of hard-coded flight commands but still being ideal for gesture control.

Critical Knowledge and Skills

Knowledge

Students will know:

- How to safely test their drone to avoid injury to themselves and their classmates.
- What motors and speeds are required for the drone to move forward, backward, left, right, or spin in place?
- Understand the drone flying modes: Joystick, Accelerometer, and Computer Control?
- Why 2 diagonal propellers must spend clockwise and the other two counter clockwise for flight to occur?
- The drone's maximum flying distance from the controller is approximately 40 feet(12.2 m)
- The drones maximum height is 2.1 to 2.6 meters from the surface it takes off.
- The Arduino Controller cannot read data from the drone.

- The drones behavior is dictated by three values: roll, pitch, and state(throttle).
- In Control Mode, drone data values(roll, pitch, and throttle) are received on the controller from the python program and then pushed to the drone.
- The Drone Data type can be thought as both a command for the drone, and as an approximation of the state the drone is in.
- The drone will adjust to achieve a command, like a 30 degree roll, but there is still some delay to achieve that, likely on the scale of milliseconds.
- Realize DroneTakeoff() and DroneLand() are not separate commands but simply toggle 1 command. If the drone is flying, and drone_land() is called, the drone will obviously land. Calling drone_land() a 2nd time, the drone will take off provided the controller and drone are still bound.
- A command will be continually sent to the drone until another command replaces it.
- To move forward or backward, modify the pitch parameter appropriately.
- To fly to the right or left, modify the roll parameter appropriately.
- However, even with initial trimming, the longer the drone flies the more drift errors can accumulate thus reducing stability despite the trim values. Initially finding trim values also will not address issues of external forces causing the drone to move. This results in this type of drone being limited in its ability to execute a series of hard-coded flight commands but still being ideal for gesture control.

Skills

Students will be able to:

- Insert the battery, inspect and repair the drone cage and propellors?
- Determine the maximum height and range of their drone when it takes off from the floor.
- Understand and use the LocoDrone class data structure.
- Get accelerometer mode and joy mode plotting working.
- Write a function to set the roll and pitch in order to trim the drone directly.
- Fly the drone in accelerometer and joy mode.
- After the drone is trimmed, hover successfully.
- From a hovering position, construct a mathematical model from experimental data to find the drone's maximum height for a given time and battery energy.
- Determine the maximum height the drone can attain.
- Measure the voltage of the drone's battery.
- Create a function to fly the drone forward or backwards.
- Create a function to have the drone fly left or fly right.
- Create an emergency landing drone function.
- Use Newton's 2nd Law and Conservation of Angular Momentum to explain how a drone can rotate without loss of hover.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
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School Summative Assessment Plan

Control Mode Drone Challenges:

Land in Target Zone at least 2 m away from takeoff. Start from Hover Position.

Fly through two perpendicular hula hoops taking off parallel to the first hoop's opening.

Primary Resources

LocoRobo Innovations: Aura Drone, Gesture Controller, Joystick Controller)

LocoRobo Academy : Drone Lessons

Anaconda Python Development Environment with Python 3 and associated libraries

Spyder and/or Sublime editors

Supplementary Resources

Python3 language refernce

"How to Think Like a Computer Scientist" 2nd edition

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.
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All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Algorithm design. Finding a mathematical model for experimental data.

SCIENCE - Understand the physics of drone flight. Strategies to take if drone overshoots target zone. How to set up an experiemnt, execute it, and analyze its data.

SOCIAL STUDIES - When were drones first invented, for what purpose and in what country? What laws have been enacted to control drone flight.

WORLD LANGUAGES - What countries are drones used in?

VISUAL/PERFORMING ARTS - How diffitcult would it be to choreograph a swarm of drones like in the opening ceremony of the 2018 Winter Olympics?

BUSINESS EDUCATION - How does one price a drone application for which no competitor's exist?

GLOBAL AWARENESS - How are drones being used to mitigate pain and suffering in the world?

Learning Plan / Pacing Guide

Week 1:

Pre-Flight Environment Setup

Done Safety

Wearble Flying Competition

Week 2:

Introduction to Joysticks

Introduction to Accelerometers

Introduction to Gyroscope

Physics of Drone Flight

Week 3:

Joystick Flying Mode

Accelerometer Flying Mode

Control Flying Mode

Week 4:

Take-off & Land in Control Mode

Hoover in Control Mode

Trim in real time using keyboard buttons.

Set TRIM directl by using a function that can be written in python.

Week 5:

Sensor Ploting (accelerometer and gyroscope)

Controller Calibration

Week 6:

Create an experiment to determine the maximum height height achieved by the drone for a given battery voltage and execution time.

What is the maximum height ever achieved by the drone? Will it crash into the classroom ceiling?

Week 7:

From multiple takeofffs with zero thrust, determine the initial hovering height.

Control MOde Functions (Combine Control Mode and Sensor Data)

Build User Defined Functions and Test:

change_drone_height(),

set_TRIM_roll_pitch()

print_TRIM_Roll_pitch()

Week 8:

Test User defined functions

Week 9:

Additional User defined functions:

fly_with_pitch(), fly_with_roll(), delay_and_test_abort()

Test functions

Week 10:

Use SDK Tello Talent: Write code with block simulator, fly in 5G, calibrate with phone

Week 11:

Tello Talent Challenges: Flay a Snake Blinking LED, a slope, a vertical circle, a sine curve and finally a Figure 8

* Unit 3: Robotic Arm *

Content Area:	**Applied Tech**
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Length:	**weeks**
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Computer Science and Design Thinking Standards

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.C.1	Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community.
TECH.8.1.12.C.CS4	Contribute to project teams to produce original works or solve problems.
TECH.8.1.12.E.1	Produce a position statement about a real world problem by developing a systematic plan of investigation with peers and experts synthesizing information from multiple sources.
TECH.8.1.12.F.CS1	Identify and define authentic problems and significant questions for investigation.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.12.B	Technology and Society: Knowledge and understanding of human, cultural and society values are fundamental when designing technology systems and products in the global society.
TECH.8.2.12.C.3	Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics).
TECH.8.2.12.C.6	Research an existing product, reverse engineer and redesign it to improve form and function.
TECH.8.2.12.C.CS2	The application of engineering design.
TECH.8.2.12.D.1	Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.4	Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types and conditional statements).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

Transfer Goals

Robotic Arms are found almost everywhere, in industrial environments performing highly repetitive or heavy duty manufacturing activities on assmebly lines, in reserach facilities precisely handling hazardous substances or in perating rooms perform delicate surgery. Robotic arms are generally designed to replicate a human arm so they are relatively similar in structure. Compared to human arms, robotics arms have reduced abilities and elevated complexities in terms of the movements they can handle and the loads they can carry. Robotic arms are defined by its number of degrees of freedom. Each degree of freedom represents a motion that the robot can perform. To develop a motion algorithm, the curent and target position are specified in both cartesian and spherical coordinates. The most simple motion algorithm to pick up and place an object uses inverse kinematics and the law of cosines to determine angles between joints. These algorithms can become complicated very quickly. Sensor data like temperature, energy, and brightness maps can refine the total number of paths to a more manageable quantity. It is hoped that the student can experience not only the software and hardware complexities of solving a problem, but also see the need for mathematics to help reduce the complexity of the problem.

Life Literacies and Key Skills

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.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).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- What mathematical model is needed to specify the robot's gripper position?
- How many Degrees of Freedom does the classroom arm contain?
- How do I prevent the code from making arm movements that will damage the arm?
- How does one detemine the optimal path for my robotic arm?
- How do I determine the fastest speed to move the arm?
- Is it best to divide a motion algorithm into parts, test each part, and then recombine for the final motion?
- How do I figure out how to control a single servo or photoresistor?
- How many times can a complete arm algorithm be repeated without failure?
- How do I use Brightness, Energy, and Temperature maps to refine my algorithm?

Understandings

Once an understanding the Degrees of Freedom of the given robotic arm is developed, use inverse kinematics and sensor data to create an algorithm to pick and place an object with repeatability.

Critical Knowledge and Skills

Knowledge

Students will know:

- Enough Python to write an application.
- Cartesian & Spherical Coordinates for specifiying the location of an object.
- Degrees of Freedom.
- Functions of a servo
- How a photoresistor works.
- How a temperature sensor works.
- How to control a gripper and its maximum extension.

Skills

Students will be able to:

- How to determine the degrees of freedom of LocoArm
- Determine the maximum extension of each servo
- Use the capabilities of LocoArm's 5 servos to accomplish a pick and place motion.
- Create software controls to prevent motions that can damage the gripper or pulll out controller wires from the base.
- How to plan a range of motion application.
- How to create sensor Maps for Brightness, Temperature, and Energy
- Identify motion errors and troubleshoot.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Project: Remove a washer from a screw and place it on another screw using photoresistor for detection of the threads of the target screw.

Primary Resources

LocoRobo Innovations Inc. Robotic Arm (Hardware, software, and lesson ideas)

Supplementary Resources

Web articles on Robotic Arm Motion

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
    - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❏ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❏ All assignments have been created in the student’s native language.

❏ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❏ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❏ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Inverse Kinematics, Law of Cosines. Python algorithm development.

SCIENCE - Knowledge and use of servos, photoresistors. Develpment of testing strategies.

SOCIAL STUDIES - What was the first application of a robotic arm? Did they develop from prosthetics used by injured soldiers in World War II? What is the state of bionic arms today?

WORLD LANGUAGES - What is the best computer langauge for programming a robotic arm?

VISUAL/PERFORMING ARTS - Can a robotic arm coupled with a master computer beat a human in chess?

APPLIED TECHNOLOGY - Have robotic arms been coupled with artifiial inteligence?

BUSINESS EDUCATION - Do robotic arms increase workplace safety, work reliably, decrease the cost of a product and displace jobs?

GLOBAL AWARENESS - Are prosthetics becoming more affordable for impoverished people?

Learning Plan / Pacing Guide

Week 1:

Install/Setup Anaconda

Python Math and Print Function

Conditional Decisions #1 If/Else, For Loops, Logical Operators,While Loops

Week 2:

Python: Using Built-In Functions

Python: User Defined Functions

Python: User Inputs #1 - Strings

Variable Scope, Flow Control, Exception Handling

Python Challenge

Week 3:

Cartesian Coordinates

Spherical Coordinates

Solving Coordinate Problems

Week 4:

Measuring Key Lengths of LocoArm appendages for spherical coordinate algorithms

Labeling LocoArm with key variable names

Determining the Degrees of Freedom(DOF)

Determining the maximum angle extension of each servo

Standalone Arduino Application for controlling a single servo

Standalone Arduino application for controlling a photoresistor

LocoExtreme Temperature Sensor

Week 5:

Study the gripper and how to control it

How to control the arm's motion

Find motion cases that should be prohibited because they can damage the gripper or pull out controlller wires from their base

Week 6:

Path Planning 1: Range of Motion

Path Planning 2: Repeatability

Path Planning 3: Obstacle Detection

Week 7:

Pick and Place Challenges 1-5

Week 8:

Sensor & Graphs

Grid Maps 1: Brightness Map

Grid Maps 2: Temperature Map

Grid Maps 3: Energy Map

Week 9:

Find Briightest Challenge

Find Warmest Challenge

Week 10:

Solar Cell 1: Energy

Solar Cell 2: Placement

Week 11:

Pick Up and Place Challenge using multiple sensors

* Unit 4: Wearable *

Content Area:	**Applied Tech**
Course(s):	**Generic Course**
Time Period:	**Marking Period 1**
Length:	**weeks**
Status:	**Published**

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
CS.9-12.8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

Students will use sensor data from an accelerometer and a gyroscope to code a real-life application where the crossing of one or multiple sensor thresholds is counted. In order to arrive at what thresholds should be counted and at what values, students need to take extensive data from their devices, find patterns in the data, and then code the counting algorithm. The student plots data in real-time using python matplotlib routines. Based on the data values and patterns they observe, the student will configure the sensitivity of the accelerometer and gyroscope to ellicit enough precision and accuracy so data thresholds are not missed.

Life Literacies and Key Skills

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
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TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- How do I determine the sensitivity of the accelerometer & gyrcospe for my application?
- How do I divide my application into manageable steps?
- How is compiling programs on the Teensy 2.0 different than the Arduino Uno?
- Do I really understand how the acceleromter and/or gyroscope work?
- How do I take data in real-time to determine sensor data patterns in my application?

Understandings

Critical Knowledge and Skills

Knowledge

Students will know:

- How the accelerometer and gyrocope work and are configured.
- The MPU 6050 outputs data in two's complement format.
- How can Two's complement represent both positive and negative numbers?
- What are the four accelerometer sensitivities?
- What are the four gyroscope sensitivities?
- How to design an algorithm and translate it into a working python=teensy application.
- Have knowledge of the list statistic function that can be used to analyze data collected from the Wearable.

Skills

Students will be able to:

- How to power up the Wearble using the PC and/or LiPo battery.
- Compile and successfully upload a Teensy program.
- How to convert 2's complement sensor data into units of 'g' based on the device's sensitivity.
- How to configure the sensitivity of the MPU 6050 accelerometer and gyroscope.
- For a given sensitivity, write the appropriate scaling function to convert the data to appropriate units of 'g'.
- Recognize data patterns.
- Use Python modules to keep track of time in a conditional logic based function.
- Use Python modules to format data in a way that is easier to visualize and evaluate.to
- Learn to determine proper threshold valuse from sensor data coordinated with a motion.
- Record and save multiple data sets from a specific repeated movement in order to analyze the differences bewteen each set.
- Handle run-time errors and debug code running on both the Tennsy and the laptop running python.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
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- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Count the "Motion" : Jogging, Dribbling a Basketball, Swinging a Meterstick, or Passing a basketball between two players at chest height.

Details are provided in the document "Wearable Design Pts: 1-4 " found in Documents:Wearable

Primary Resources

LocoRobo Innovations:Teensy Based Wrist Wearable with single digit tri-color display, accelerometer and gyroscope(MPU 6050)

Teensy Board Development Environment

MPU 6050 Specifications Document

Display Code software

Anaconda Python Development Environment with Python 3 and associated libraries

Spyder and/or Sublime editors

Supplementary Resources

General knowlege of accelerometers operation and coding from LocoRobo's LocoExtreme.

Python3 language refernce

"How to Think Like a Computer Scientist" 2nd edition

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
    - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.

❑ All assignments have been created in the student’s native language.

❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

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All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Acquire sensor data, align person's movement with data acquistion, and observe data thresholds at key movements.

Determine a method for converting a positive or negative integer into 1 2's complement binary number.

SCIENCE - Insure that the data acquisition and data display is off by no more than 5 msecs.

SOCIAL STUDIES - What was the first application of the accelerometer?

WORLD LANGUAGES - Could a wearable device be developed that could check proper hand movements for one learning sign language?

VISUAL/PERFORMING ARTS - Could ballet dancers wear these devices on their ankles and wrists which would alert them when they were dancing was

falling short of meeting the thresholds dictated by their dnce routine?

BUSINESS EDUCATION - Why is Michael Trout marketing a device with dual accelerometers and a 3 axis gyroscope that measures

his batting swing? The product is known as "Zepp".

GLOBAL AWARENESS - How can this technology be used to make the lives of impoverished people better?

Learning Plan / Pacing Guide

Week 1:

Refresh knowlege of accelerometer. Read the MPU 6050 DataSheet.

Work through Tutorial #1 about the Wearble's hardware and software.

Download the 1st program to count wirst thresholds and experiment.

Modify the python code so the Wearbale only detects strong, powerful shakes, not weak shakes.

Week 2:

Explain what functions to use to change the sensitivity of the MPU 6050 accelerometer and gyroscope

Change the sensitivity based on the maximum measurement needed, verify with a data stream

Use python modules like matplotlib for plotting sensor data transferred from the teensy to the laptop running python.

Shift the sensor scaling from the teensy to the laptop to eliminate dropped data on the teensy.

Use Python modules for time calculations, formatting data, and advanced math.

Weeks 3 & 4:

Take data from a real-life human motion application.

Analyze the data to determine data thresholds.

Create an algorithm which uses states defined by conditional logic to count the motion.

Display this count to the user via the display.

If the motion is incomplete, the algorithm needs to restart.

Weeks 5 & 6:

Complete the Wearable Application and demonstrate. See Summative Assessment for more details.

* Unit 5: Renewable Energy *

Content Area:	**Applied Tech**
Course(s):	**Generic Course**
Time Period:	**Marking Period 1**
Length:	**weeks**
Status:	**Published**

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
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CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

Renewable Energy using wind turbines and solar cells provides an economic and technical framework for the study of scientific concepts of energy storage and transformations. The successful utilization of renewable energy rests on the development of technical skills: engineering research and design; electrical power production, transmission, and utilization; manufacturing; and urban planning and design. Students will experience these subject areas as they design wind farms and solar panels. Student knowldege will be shaped by running simulations.

Life Literacies and Key Skills

TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
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TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- How do solar cells capture energy?
- How long can energy be stored on a solar cell?
- How is energy stored from a wind turbine?
- How does one go about designing a solar panel array that effectively balances its power output with cost?
- How does one go about designing a wind farm that effectively balances its power output with cost?

Understandings

Designing an effective solar cell involves characterizing the functional relationship between power loss and finger dimensions. Solar design fundamentals depend on the relationship between the solar cell finger dimensions(spacing, length, depth, and width) and power loss relative to ideal output. Windmill design depends on teh relationship between number, length, and pitch of the angle blades and power output.

Critical Knowledge and Skills

Knowledge

Students will know:

- How series and parallel connections connections are used to create solar arrays that maximize power generation.
- How solar cell finger length affects the maximum power output of a solar cell.
- How the relationship between windmill spacing will optimize the relationship between blade characteristics and the cumulative power output of the windmills.
- How to grow the model for one wind turbine to planning a wind farm.
- The current- voltage characteristics of a series or parallel solar array.

Skills

Students will be able to:

- Connect a solar cell to a micrcomputer and extract data to characterize its energy output.
- Characterize the energy losses in a solar cell array due to fingers, shading, and the cell sheet.
- Characterize the functional relationship between power output and windspeed for a single windmill.
- Design a windfarm that maximizes power output for a fixed cost.
- Design a windmill that can provide the maximum power output given a particular windspeed.
- Mathematically model the current-voltage output of a solar array or panel.
- Specify the relationship between the positioning of a static set of solar cells and solar output for different parts of the United States.

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Projects:

- Design a Solar Cell Farm to supply the needs of West Deptford Township.
- Design a windfarm to supply the energy needs of West Deptford Township
- Build a solar array and measure its maximum current output.

Primary Resources

LocoRobo Innovations Inc. LocoEnergy Simulations

Supplementary Resources

Renewable Energy Design Articles

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
  - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
  - GAFE (Google Apps For Education) - Using various programs connected with Google to

collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
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❏ All assignments have been created in the student's native language.

❏ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

❏ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

❏ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.

❏ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Use of algebraic models for energy output and loss calculations.

SCIENCE - Units of Energy, Energy Consumption Models, Power vs. Energy, Energy Efficiency, Solar mass, Passive solar, Solar gain.

SOCIAL STUDIES - Are countries legislating policy that rewards the use of renewable energy resources?

WORLD LANGUAGES - Does renewable energy vocabulary appear in Spanish, French, Chinese, Arabic, and Indian languages or dialects?

VISUAL/PERFORMING ARTS - How are popular entertainers championing the cause of renewable energy?

BUSINESS EDUCATION - Is renewableresources energy cost efficient?

GLOBAL AWARENESS - Should there be a policy(like a carbon tax) that rewards companies for using renewable energy resources so the pace of global warming can be slowed?

Learning Plan / Pacing Guide

Week 1:

Wind Turbine Design:

Introduction

Pre-Lab

Experiments: 1-5

Week 2:

Wind Farm Design:

Introduction

Pre-Lab

Experiments: 1-5

Week 3:

Solar Cell Design:

Introduction

Pre-Lab

Experiments: 1-6

<u>Week 4:</u>

Solar Panel Design:

Introduction

Pre-Lab

Experiments: 1-5

* Unit: 6: Arduino and Circuit Design *

Content Area: **Applied Tech**
Course(s): **Generic Course**
Time Period: **Marking Period 1**
Length: **weeks**
Status: **Published**

Computer Science and Design Thinking Standards

CS.9-12.8.1.12.AP.1	Design algorithms to solve computational problems using a combination of original and existing algorithms.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
CS.9-12.8.1.12.AP.6	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.DA.4	Explain the relationship between binary numbers and the storage and use of data in a computing device.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
CS.9-12.8.2.12.NT.2	Redesign an existing product to improve form or function.
CS.9-12.8.2.12.ITH.1	Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

Transfer Goals

Students will be able to independently use their learning to construct electronic circuits, some independent and some connecting to the Arduino. Starting with copper foil circuits and ending with breadboard circuits, students will acquire experience building circuits, measuring current and voltage with meters, and analyzing them with Kirchoff's Voltage and Current Laws. Troubleshooting skills including isolating a problem will be developed. Students will then study the Arduino and its IDE platform. The Arduino uses a "C" like programming language which is much different than Python. Students will breadboard circuits for the first time. Simple Arduino applications(hardware and software) are done including blinking an LED and using a pushbutton to control an LED. The point is to develop a skill set which will be put to use when building(hardware and software) an advanced Arduino project.

Life Literacies and Key Skills

TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.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).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.DC.1	Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
TECH.9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
TECH.9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).

Concepts

Essential Questions

- How are voltage, current, and resistance related?
- How does the resistance of a resistor affect power consumption within a circuit?
- What is electric charge, and how is it distinct from other properties of matter?
- What is required for an electrical circuit?
- Why are most building wired in parallel?
- Which is brighter, bulbs in a series or parallel circuit?
- What isn't the Arduino as powerful as my laptop?
- How do I troubleshoot a hardware problem?
- What is meant by isolating a hardware or software problem?
- What is an Arduino? Arduino IDE?

Understandings

Students will intuitively build models for current flow in DC series, current and combination circuits to the extent that they can use their model to justify why disconnecting a lightbulb turns the entire circuit off or makes some light bulbs in the circuit brighter than others. A model of resiistance is developed and Ohm's law is cited. A model for electrical power, that it depends on the product of current and voltage, is created. Students are intuitively devleloping Kirchoof's current and voltage laws, though a quantitative application of these laws is best left to a physics class due to the lack of time. Attempts are made to apply energy concepts to explain V = IR i.e How much work must be done(V) to push a specific quantity of charge (I) across a particular obstacle(R)? Students will understand the fundamentals of the Arduino, enough to breadboard a basic circuit connected to the Arduino and controlled by software the student writes.

Critical Knowledge and Skills

Knowledge

Students will know:

- Batteries push current through resistances, they are not current sources.
- Series is an "and", same current flows through every device no matter how wired.
- In a series circuit, all devices are dependent on each other. - All on or All fail.
- More devices = more total resistance
- For a given voltage or energy source, increasing the number of devices decreases the current flow.
- In Parallel circuits, each device has its on path, and each device can be on or off regardless of the other devices.
- More devices = more potential pathways for current flow
- For a given voltage(energy) source, increasing the number of devices increases the current flow.
- Kirchoof's loop rule is a statement of energy conservation: You can't get out more than you put in.
- Kirchoof's Junction Rule is charge conservation, you can't lose electrons.
- Breadboard a circuit controlled by the Arduino using wires, LED's resistors, and a voltage source.
- How to use a breadboard.
- Arduino Program is called a sketch.
- Circuits need to be connected to ground.
- Understand the use of Arduino IDE setup() and loop().
- Difference between Analog and Digital Pins.
- Uses for the Arduino Serial Port.

Skills

Students will be able to:

- Build series, parallel, and combination circuits using lightbulbs, batteries, wires, and switches.
- Troubleshoot a circuit when it does not work.
- Provide an explanation for the brightness of light bulbs in a circuit.
- Apply Ohm's Law, Power equation, and Kirchoff's Laws in analyzing the brightness of Light bulbs in a circuit.
- Breadboard a circuit.
- Write C Programming Code to control an Arduino breadboard application..
- Troubleshoot Arduino Hardware and Software.
- Use a Voltmeter for measurement and conductivity testing.
- Use PhET DC Circuit Simulator to build and test complicated circuits.
- Learn How to Solder.
- Qualitatively apply Ohm's Law, Power, and Kirchoff Laws in analyzing

Assessment and Resources

School Formative Assessment Plan (Other Evidence)

- Students come together in groups(2-3 students) to Share Problems or Solutions to Problems with the entire class using whiteboards for discussion.
- Teacher sits down with each student at least twice a class to assess what they have accomplished and bottlenecks
- Groups whiteboard algorithms on whiteboards and sollicit feedback from the rest of the class
- Students pose questions on Google Classroom
- Students directly request teacher's assistance if other students can't answer their questions.
- Thumbs up, middle, or down to indicate concept understanding

School Summative Assessment Plan

Performance Assessment- Given a 4 light bulb bathroom bar circuit wired by this teacher, students are tasked with determining how it is wired by systematically removing light bulbs from the circuit.

Quiz/Test on DC circuit fundamentals using light bulb circuits.

Breadboard a LED circuit and control it through the Arduino.

Primary Resources

PhET DC Circuit Analysis Simulator

Circuit Construction Materials(wires, bulbs, batteries, voltmeters)

College Physics by Etknia, Pearson 2014

Make: Getting Started with Arduino 3rd Edition Massimo Banzi & Michael Shiloh

Supplementary Resources

Universe and More "Crack the Circuit" Game http://the universeandmore.com

Technology Integration and Differentiated Instruction

Technology Integration

- **Google Products**
    - Google Classroom - Used for daily interactions with the students covering a vast majority of different educational resources (Daily Notes, Exit Tickets, Classroom Polls, Quick Checks, Additional Resources/ Support, Homework, etc.)
    - GAFE (Google Apps For Education) - Using various programs connected with Google to collaborate within the district, co-teachers, grade level partner teacher, and with students to stay connected with the content that is covered within the topic. Used to collect data in real time and see results upon completion of the assignments to allow for 21st century learning.

- **One to One Student's laptop**
    - All students within the West Deptford School District are given a computer, allowing for 21st century learning to occur within every lesson/topic.

Differentiated Instruction

Gifted Students (N.J.A.C.6A:8-3.1)

- ❑ Within each lesson, the Gifted Students are given choice on topic and subject matter allowing them to explore interests appropriate to their abilities, areas of interest and other courses.

English Language Learners (N.J.A.C.6A:15)

- ❑ Within each lesson, the English Language Learners are given choice of topic and resources so that their materials are within their ability to grasp the language.
- ❑ All assignments have been created in the student's native language.
- ❑ Work with ELL Teacher to allow for all assignments to be completed with extra time.

At-Risk Students (N.J.A.C.6A:8-4.3c)

- ❑ Within each lesson, the at-risk students are given choice of topic and resources so that their materials are within their ability level and high-interest.

Special Education Students (N.J.A.C.6A:8-3.1)

- ❑ Within each lesson, special education students are given choice of topic and resources so that their materials are within their ability level and high-interest.
- ❑ All content will be modeled with examples and all essays are built on a step-by-step basis so modifications for assignments in small chunks are met.

All other IEP modifications will be honored (ie. hard copies of notes, directions restated, etc.)

Interdisciplinary Connections

MATH - Develop the mathematical models for Ohm's Laws, and Kichoff's Current and Voltage Laws.

SCIENCE - Use Conservation of Energy to explain voltage sums around a ciruit loop and the conservation of charge to explain Kirchoff's Current Law.

SOCIAL STUDIES - The Arduino microcontroller was invented in Italy by self-proclaimed tinkerer

Massimo Banzi.

WORLD LANGUAGES - How many languages has "Getting Started with Arduino" been translated into?

VISUAL/PERFORMING ARTS - Arduino was created for artists and designers to build projects without requiring a sophisticated knowldege of electronics.

BUSINESS EDUCATION - Is Arduino still a viable option for artists and hobbyists to prototype and electromechanical devices?

GLOBAL AWARENESS - How has Arduino been used as an education device for introducing programming and electronics to students from around the world?

Learning Plan / Pacing Guide

Week 1:

Experiment with building paper, foil, and battery LED circuits.

Devise a model for Charge flow - what happnes if two LED's are wired in series or in parallel?

Week 2:

Build 8 lightbulb circuits and account for the brightness of each bulb.

Define series and paraleel circuits and account for current and voltage for each of these circuits.

Continue analyzing combiantion series and parallel circuits qualitatitvely, but OK to develop the mathematical model for the law if students desire.

Introduce PhET DC circuit analysis as a tool for analyzing circuits. Can make voltage and current measurements with this tool.

Week 3:

Quiz on DC circuit Fundamentals(Randking Voltage, Current, and Bulb Brightness)

Introduction to Arduino.

Fundamentals of Breadboarding.

Soldering Experience: Makey Badge and/or Electronic LED Game.

Week 4:

Breadboard LED(s) Arduino Circuit. Start with one LED and progress to multiple LED's, pusbutton applications, etc.

Weeks 5--7:

Culminating Project:

Build a Pulse Monitor using an Arduino and a Grove Ear Clip Heart Rate Sensor.

Provide a software template with 80% of the code written.