8th GRADE Pre-Engineering Curriculum

This curricula and accompanying instructional materials have been developed to align with the NJSLS and in accordance with the NJ Department of Education's guidelines to include: Curriculum designed to meet grade level expectations, integrated accommodations and modifications for students with IEPs, 504s, ELLs, and gifted and talented students, assessments including benchmarks, formative, summative, and alternative assessments, a list of core instructional and supplemental materials, pacing guide, interdisciplinary connections, integration of 21st century skills, integration of technology, and integration of 21st Century Life and Career standards.

About the Standards

In 1996, the New Jersey State Board of Education adopted the state's first set of academic standards called the Core Curriculum Content Standards. The standards described what students should know and be able to do upon completion of a thirteen-year public school education. Over the last twenty years, New Jersey's academic standards have laid the foundation for local district curricula that are used by teachers in their daily lesson plans.

Revised every five years, the standards provide local school districts with clear and specific benchmarks for student achievement in nine content areas. Developed and reviewed by panels of teachers, administrators, parents, students, and representatives from higher education, business, and the community, the standards are influenced by national standards, research-based practice, and student needs. The standards define a "Thorough and Efficient Education" as guaranteed in 1875 by the New Jersey Constitution. Currently the standards are designed to prepare our students for college and careers by emphasizing high-level skills needed for tomorrow's world.

Integration of Technology

8.1.8.CS.1: Recommend improvements to computing devices in order to improve the ways users interact with the devices.
Software and hardware determine a computing system's capability to store and process information. The design or selection of a computing system involves multiple considerations and potential trade-offs.
• 8.1.8.CS.2: Design a system that combines hardware and software components to process data.
• 8.1.8.CS.3: Justify design decisions and explain potential system trade-offs. Troubleshooting a problem is more effective when knowledge of the specific device along with a systematic process is used to identify the source of a problem.
8.1.8.CS.4: Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.

21st Century Skills

9.3.ST- ET.1 Use STEM concepts and processes to solve problems involving design and/or production.
9.3.ST- ET.2 Display and communicate STEM information.
9.3.ST- ET.3 Apply processes and concepts for the use of technological tools in STEM.
9.3.ST- ET.4 Apply the elements of the design process.
9.3.ST- ET.5 Apply the knowledge learned in STEM to solve problems.
9.3.ST- ET.6 Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.

Career Education

9.2.8.CAP.1: Identify offerings such as high school and county career and technical school courses, apprenticeships, military programs, and dual enrollment courses that support career or occupational areas of interest.
9.2.8.CAP.2: Develop a plan that includes information about career areas of interest.
9.2.8.CAP.3: Explain how career choices, educational choices, skills, economic conditions, and personal behavior affect income.
9.2.8.CAP.4: Explain how an individual's online behavior (e.g., social networking, photo exchanges, video postings) may impact opportunities for employment or advancement.
9.2.8.CAP.5: Develop a personal plan with the assistance of an adult mentor that includes information about career areas of interest, goals and an educational plan.
9.2.8.CAP.6: Compare the costs of postsecondary education with the potential increase in income from a career of choice. 9.2.8.CAP.7: Devise a strategy to minimize costs of postsecondary education.
9.2.8.CAP.8: Compare education and training requirements, income potential, and primary duties of at least two jobs of interest. 9.2.8.CAP.9: Analyze how a variety of activities related to career preparation (e.g., volunteering, apprenticeships, structured learning experiences, dual enrollment, job search, scholarships) impacts postsecondary options.
9.2.8.CAP.10: Evaluate how careers have evolved regionally, nationally, and globally.

9.2.8.CAP.11: Analyze potential career opportunities by considering different types of resources, including occupation databases, and state and national labor market statistics.
9.2.8.CAP.12: Assess personal strengths, talents, values, and interests to appropriate jobs and careers to maximize career potential.
9.2.8.CAP.13: Compare employee benefits when evaluating employment interests and explain the possible impact on personal finances.
9.2.8.CAP.14: Evaluate sources of income and alternative resources to accurately compare employment options.
9.2.8.CAP.15: Present how the demand for certain skills, the job market, and credentials can determine an individual's earning power.
9.2.8.CAP.16: Research different ways workers/ employees improve their earning power through education and the acquisition of new knowledge and skills.
9.2.8.CAP.17: Prepare a sample resume and cover letter as part of an application process.
9.2.8.CAP.18: Explain how personal behavior, appearance, attitudes, and other choices may impact the job application process. 9.2.8.CAP.19: Relate academic achievement, as represented by high school diplomas, college degrees, and industry credentials, to employability and to potential level
9.2.8.CAP.20: Identify the items to consider when estimating the cost of funding a business.

Lower Cape May Regional School District 8th Grade Pre-Engineering Curriculum

Content Area: Computer Science and Design Thinking

Course Title: Design and Code Foundations (Semester 1)
Grade level: 8

Semester Summery:
Design and Code Foundations introduces eighth-grade students to the interconnected world of computational thinking, programming, and digital manufacturing through hands-on projects that build foundational skills in design thinking, Python programming, 3D modeling, and physical computing. Students begin by learning the design process and basic programming concepts using Python Turtle graphics, then progress to creating interactive digital applications with functions, loops, and user input while simultaneously exploring 3D design in Fusion 360. The curriculum integrates these digital skills with physical computing as students learn to program Maker Pi RP2040 (or ESP32) microcontrollers, work with sensors and actuators, and create responsive electronic systems. Throughout the semester, students develop critical thinking and collaboration skills while learning to document their work and iterate on designs. The course culminates in a capstone project that synthesizes all learned technologies—design thinking, programming, 3D modeling, and physical computing—into a functional prototype that solves a real-world problem, preparing students for more advanced engineering challenges.

Unit / Big Idea	Time Frame
Design Thinking & Computational Foundations	**Week 1**
Programming Fundamentals & Interactive	**Week 2**

Design	
Logic, Variables & 3D Design Introduction	**Week 3**
Physical Computing & Electronics Basics	**Week 4**
Sensors, Inputs & Responsive Systems	**Week 5**
Integrated Design & Systems Thinking	**Week 6**
Capstone Project & Presentation	**Week 7**

Course Title: Engineering and Intelligent Systems (Semester 2)
Grade level: 8

Semester Summery:
Engineering and Intelligent Systems builds upon foundational programming and design skills to explore how modern technology creates "smart" systems that can perceive, reason, and respond to their environment autonomously. Students begin by investigating what makes systems intelligent, learning to work with various sensors and implement decision-making logic that enables automated responses to environmental conditions. The curriculum progresses through motion control and mechanical integration, where students design and build robotic systems using 3D-printed components and precise servo control, while simultaneously learning to collect and analyze data from their systems over time. Advanced topics include an introduction to artificial intelligence and machine learning concepts, paired with human-centered design methodology that emphasizes ethics, user experience, and empathy in technology development. Students learn to plan and architect complex systems through detailed documentation and team collaboration, ultimately culminating in sophisticated capstone projects that integrate sensors, actuators, AI concepts, 3D design, and programming into intelligent systems that address real-world challenges. This semester prepares students to think critically about the role of intelligent technology in society while developing advanced technical skills in robotics, data analysis, and system design.

Unit / Big Idea	**Time Frame**
Intelligent Systems & Sensor Fundamentals	**Week 1**
Decision Making & Automated Responses	**Week 2**
Motion Control & Mechanical Integration	**Week 3**
Systems Integration & Data Intelligence	**Week 4**
Artificial Intelligence & Human-Centered Design	**Week 5**
Advanced System Design & Project	**Week 6**

Planning	
Capstone Implementation & Showcase	**Week 7**
Date Created: June	**Board Approved On:**
Date Revised:	

Lower Cape May Regional School District 8th Grade Pre-Engineering Curriculum Unit Overview

Semester 1
Unit Title: Design Thinking & Computational Foundations
Big Idea: *What is Design Thinking and Computational Problem-Solving?*
Activities & Projects ● Design Challenge: Build a paper tower ● Intro to course & digital notebook setup ● Flowchart activity and algorithm card sorting ● Intro to Python with Magic 8 Ball Game ● Group norms & creative problem-solving games
CPI ● 8.2.8.ED.1: Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer. ● 8.2.8.ITH.3: Evaluate the impact of sustainability on the development of a designed product or system. ● 8.1.8.AP.1: Design and illustrate algorithms that solve complex problems using flowcharts and/or pseudocode.
Vocabulary (One Sentence) ● **Algorithm** - Step-by-step instructions to solve a problem ● **Design Process** - Iterative method for creating solutions ● **Decomposition** - Breaking complex problems into smaller parts ● **Collaboration** - Working together effectively in teams ● **Iteration** - Repeating and improving a process ● **Prototype** - Early model of a product for testing ● **Flowchart** - Visual representation of a process or algorithm
Unit Enduring Understandings ● Design thinking is a human-centered approach to innovation that integrates the

needs of people, possibilities of technology, and requirements for success
- Computational thinking involves breaking down complex problems into manageable parts using algorithms and logical reasoning
- Effective collaboration and communication are essential for successful design and engineering projects

Unit Objectives: Students will know...
- The steps of the design thinking process (empathize, define, ideate, prototype, test)
- What algorithms are and how they solve problems systematically
- Basic Python syntax
- How to create and interpret flowcharts
- The importance of iteration in design and problem-solving

Unit Objectives: Students will be able to...
- Apply the design process to solve open-ended challenges
- Write simple algorithms and represent them visually
- Create basic geometric shapes using Python Turtle graphics
- Collaborate effectively in team settings
- Document their learning process in a digital notebook

Unit Title: Programming Fundamentals & Interactive Design

Big Idea: *How do we create interactive digital experiences?*

Activities & Projects
- Build interactive shapes and patterns with Turtle
- Create a "digital doodlebot" with user input
- Design a geometric art tool using functions
- Implement keyboard commands for drawing

CPI
- 8.1.8.AP.2: Create clearly named variables that represent different data types and perform operations on their values.
- 8.1.8.AP.3: Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.
- 8.1.8.AP.4: Decompose problems and sub-problems into parts to facilitate the design, implementation, and review of programs.

Vocabulary (One Sentence)
- **Function** - Reusable block of code that performs a specific task
- **Loop** - Code structure that repeats instructions
- **Input** - Data received from the user or environment
- **Variable** - Container that stores data values
- **Syntax** - Rules for writing code in a programming language
- **Interactive** - Responding to user actions or inputs

- **Parameter** - Information passed to a function

Unit Enduring Understandings

- Programming is a creative process that allows us to express ideas and solve problems through code
- Functions and loops make code more efficient and easier to maintain
- Interactive systems respond to user input in meaningful ways

Unit Objectives: Students will know...

- How to use loops to create patterns and repetitive actions
- The purpose and structure of functions in programming
- How to capture and process user input in Python
- Basic debugging strategies for common coding errors
- The relationship between mathematical concepts and programming

Unit Objectives: Students will be able to...

- Write Python programs using loops, functions, and input statements
- Create interactive drawing programs that respond to user commands
- Debug simple programming errors independently
- Design and implement geometric art using code
- Explain how their code works to others

Unit Title: Logic, Variables & 3D Design Introduction

Big Idea: *How do we make decisions in code and design in three dimensions?*

Activities & Projects

- Build a number guessing game with conditional logic
- Explore game state variables and user feedback
- CAD design challenge: Create a custom keychain or tag in Fusion 360
- Learn sketch, extrude, and basic modeling too

CPI

- 8.1.8.AP.3: Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.
- 8.1.8.AP.4: Decompose problems and sub-problems into parts to facilitate the design, implementation, and review of programs.
- 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.NT.1: Examine a malfunctioning tool, product, or system and propose solutions to the problem.

Vocabulary (One Sentence)

- **Conditional** - Code that makes decisions based on conditions
- **CAD** - Computer-Aided Design software for 3D modeling

- **Extrude** - Extending a 2D shape into 3D space
- **Sketch** - 2D outline that forms the basis of 3D models
- **Constraint** - Rules that define relationships in CAD models
- **Boolean** - Data type with only True or False values
- **Dimension** - Measurement that defines size in design

Unit Enduring Understandings

- Conditional logic allows programs to make decisions and respond differently based on various scenarios
- 3D modeling translates creative ideas into physical designs that can be manufactured
- Variables store and track changing information throughout a program's execution

Unit Objectives: Students will know...

- How conditional statements (if/else) control program flow
- The role of variables in storing and updating game state
- Basic 3D modeling concepts and terminology
- How to navigate the Fusion 360 interface and tools
- The relationship between 2D sketches and 3D models

Unit Objectives: Students will be able to...

- Create programs that make decisions using conditional logic
- Design and implement a functional guessing game
- Create basic 3D models using sketching and extrusion
- Apply design constraints and dimensions in CAD software
- Iterate on designs based on testing and feedback

Unit Title: Physical Computing & Electronics Basics

Big Idea: *How do we bridge the digital and physical worlds?*

Activities & Projects

- Introduction to Maker Pi RP2040 microcontroller
- Electronics safety and basic circuit layout
- Program LED blinking and patterns using MicroPython
- Create custom 3D printed cases or components for electronics
- Prepare STL files for 3D printing

CPI

- 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.
- 8.2.8.ITH.2: Compare how technologies have influenced society over time.
- 8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose.

- 8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital).

Vocabulary (One Sentence)

- **Microcontroller** - Small computer that controls electronic devices
- **Circuit** - Path that electric current flows through
- **GPIO** - General Purpose Input/Output pins on microcontrollers
- **MicroPython** - Version of Python designed for microcontrollers
- **LED - Light Emitting Diode, a type of electronic light**
- **STL** - Standard file format for 3D printing
- **PWM** - Pulse Width Modulation for controlling power

Unit Enduring Understandings

- Physical computing connects digital programming with real-world interactions and feedback
- Safety protocols are essential when working with electronics and manufacturing tools
- 3D printing bridges digital design with physical manufacturing

Unit Objectives: Students will know...

- Basic electronics safety procedures and best practices
- How microcontrollers differ from regular computers
- The process of preparing 3D models for printing
- How to write and upload code to microcontrollers
- The relationship between digital design and physical manufacturing

Unit Objectives: Students will be able to...

- Set up and program the Maker Pi RP2040 safely
- Create basic LED control programs using MicroPython
- Design and export 3D models ready for printing
- Follow safety protocols when working with electronics
- Troubleshoot basic hardware and software issues

Unit Title: Sensors, Inputs & Responsive Systems

Big Idea: *How do we create systems that respond to their environment?*

Activities & Projects

- Build interactive systems using buttons, sensors, and potentiometers
- Create a "reaction timer" game with input/output
- Program servo motor control
- Combine loops with sensor input for dynamic responses

CPI

- 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.
- 8.2.8.ITH.2: Compare how technologies have influenced society over time.
- 8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose.
- 8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital).

Vocabulary (One Sentence)

- **Sensor** - Device that detects and measures physical conditions
- **Analog** - Continuous signal that can have any value in a range
- **Digital** - Signal that has only discrete values (on/off)
- **Servo** - Motor that can be precisely controlled for position
- **Potentiometer** - Variable resistor used to control circuits
- **Feedback** - Information about system output used to improve performance
- **Responsive** - System that reacts appropriately to input changes

Unit Enduring Understandings

- Responsive systems use sensors to gather information about their environment and react accordingly
- The integration of inputs and outputs creates interactive experiences
- Real-time feedback improves user experience and system effectiveness

Unit Objectives: Students will know...

- The difference between analog and digital signals
- How various sensors detect environmental conditions
- Methods for controlling motors and actuators
- How to process and respond to multiple inputs simultaneously
- The importance of timing in interactive systems

Unit Objectives: Students will be able to...

- Program systems that respond to sensor input
- Create interactive games using physical controls
- Control servo motors and LED arrays programmatically
- Integrate multiple inputs to create complex behaviors
- Design user interfaces that provide clear feedback

Unit Title: Integrated Design & Systems Thinking

Big Idea: *How do we integrate digital design with physical computing?*

Activities & Projects

- Design interactive Fusion 360 models that integrate with electronics
- Plan mechanical systems that work with programmed behaviors
- Create prototypes that combine 3D printed parts with circuits

- Test and iterate on integrated design solutions

CPI

- 8.1.8.AP.5: Create procedures with parameters to organize code and make it easier to reuse.
- 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact.
- 8.1.8.AP.6: Refine a solution that meets users' needs by incorporating feedback from team members and users.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

Vocabulary (One Sentence)

- **Integration** - Combining different systems to work together
- **Mechanical** - Related to physical movement and forces
- **System** - Collection of parts working together for a purpose
- **Interface** - Point where different systems meet and interact
- **Tolerance** - Acceptable range of variation in manufacturing
- **Assembly** - Process of putting components together
- **Optimization** - Making something as effective as possible

Unit Enduring Understandings

- Successful products require thoughtful integration of digital design, physical manufacturing, and electronic control
- Systems thinking helps designers consider how all components work together
- Iteration and testing are essential for creating reliable integrated solutions

Unit Objectives: Students will know...

- How to design mechanical systems that accommodate electronics
- The importance of tolerances and fit in integrated designs
- Methods for planning complex projects with multiple components
- How digital design decisions affect physical manufacturing
- Strategies for testing and validating integrated systems

Unit Objectives: Students will be able to...

- Design 3D models that integrate with electronic components
- Plan projects that require coordination between design and programming
- Create functional prototypes using multiple technologies
- Test integrated systems and identify areas for improvement
- Document design decisions and their impact on system performance

Unit Title: Capstone Project & Presentation

Big Idea: *How do we synthesize learning into a meaningful solution?*

Activities & Projects

- Teams design and build comprehensive capstone projects
- Integration of all semester skills: design thinking, programming, 3D modeling, and physical computing
- Create working prototypes that solve real-world problems
- Present projects to peers and provide constructive feedback
- Reflection on learning journey and future applications

CPI

- 8.1.8.AP.5: Create procedures with parameters to organize code and make it easier to reuse.
- 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact.
- 8.1.8.AP.6: Refine a solution that meets users' needs by incorporating feedback from team members and users.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

Vocabulary (One Sentence)

- **Synthesis** - Combining elements to create something new
- **Prototype** - Working model built to test and demonstrate ideas
- **Presentation** - Formal sharing of ideas and results
- **Documentation** - Recording process, decisions, and outcomes
- **Reflection** - Thoughtful consideration of learning and growth
- **Iteration** - Repeated cycles of improvement
- **Innovation** - Creating new solutions to existing problems

Unit Enduring Understandings

- Meaningful projects require synthesis of multiple skills and technologies
- Effective communication is essential for sharing technical work with others
- Reflection on the design process leads to improved future performance
- Innovation emerges from combining existing technologies in new ways

Unit Objectives: Students will know...

- How to plan and execute complex, multi-faceted projects
- Effective strategies for team collaboration on technical projects
- Methods for documenting and communicating technical work
- The value of peer feedback in the design process
- How their learning connects to real-world applications

Unit Objectives: Students will be able to...

- Synthesize design thinking, programming, and manufacturing skills
- Work effectively in teams to complete complex projects
- Present technical work clearly to diverse audiences
- Provide and receive constructive feedback on design solutions
- Reflect critically on their learning process and identify areas for growth

Semester 2

Unit Title: Intelligent Systems & Sensor Fundamentals

Big Idea: *What makes a system "intelligent" and how do sensors provide environmental awareness?*

Activities & Projects

- Explore smart devices and brainstorm "What makes something smart?"
- Design a fictional smart product concept
- Introduction to light, temperature, and humidity sensors with Maker Pi
- Compare analog vs digital sensor readings
- Build simple sensor monitoring systems

CPI

- 8.1.8.CS.1: Recommend improvements to computing devices in order to improve the ways users interact with the devices.
- 8.2.8.NT.1: Examine a malfunctioning tool, product, or system and propose solutions to the problem.
- 8.1.8.AP.5: Create procedures with parameters to organize code and make it easier to reuse.
- 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact.

Vocabulary (One Sentence)

- **Intelligent System -** Technology that can perceive, reason, and respond autonomously
- **Sensor -** Device that detects and measures environmental conditions
- **Analog -** Continuous signal that varies smoothly over a range
- **Digital -** Discrete signal with distinct on/off or numerical values
- **Threshold -** Specific value that triggers a system response
- **Autonomy -** Ability to operate independently without human control
- **Perception -** Process of gathering and interpreting environmental information

Unit Enduring Understandings

- Intelligent systems combine sensing, processing, and responding to create autonomous behaviors
- The choice between analog and digital sensors depends on the precision and type of data needed
- Real-world intelligence emerges from the integration of multiple sensing modalities

Unit Objectives: Students will know...

- Characteristics that distinguish intelligent systems from simple automated devices
- How different types of sensors detect environmental conditions
- The difference between analog and digital data collection
- Examples of intelligent systems in everyday life

- Basic principles of how sensors convert physical phenomena into electrical signals

Unit Objectives: Students will be able to...

- Identify intelligent systems in their environment and explain what makes them "smart"
- Connect and read data from multiple sensor types
- Write code to monitor and display sensor readings
- Compare analog and digital sensor outputs for the same phenomenon
- Design concepts for intelligent systems that solve real-world problems

Unit Title: Decision Making & Automated Responses

Big Idea: *How do intelligent systems make decisions and respond to changing conditions?*

Activities & Projects

- Build an automatic night-light using light sensors
- Implement if/else logic with sensor thresholds
- Create data visualizations and graphs in Thonny
- Design a plant watering alarm system with timing controls
- Experiment with delays, loops, and time-based automation

CPI

- 8.1.8.CS.4: Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.
- 8.1.8.DA.3: Identify the appropriate tool to access data based on its file format.
- 8.1.8.AP.6: Refine a solution that meets users' needs by incorporating feedback from team members and users.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

Vocabulary (One Sentence)

- **Automation** - Technology that performs tasks without human intervention
- **Boolean** - Data type with only True or False values
- **Conditional** - Programming structure that executes code based on conditions
- **Logic** - Systematic reasoning used in decision-making processes
- **Threshold** - Boundary value that determines when actions are triggered
- **Algorithm** - Step-by-step procedure for solving problems or making decisions
- **Feedback** - Information about system output used to adjust behavior

Unit Enduring Understandings

- Intelligent decision-making requires clear logic rules and appropriate threshold values
- Automated systems can respond to environmental changes without human intervention
- Time-based automation allows systems to perform scheduled or delayed actions

Unit Objectives: Students will know...

- How boolean logic forms the foundation of automated decision-making
- Methods for setting appropriate sensor thresholds for reliable operation
- The role of timing in automated systems
- How to visualize and interpret sensor data over time
- Common patterns in automated system responses

Unit Objectives: Students will be able to...

- Program systems that make decisions based on sensor input
- Create automated responses using conditional logic and thresholds
- Implement time-based automation with delays and scheduling
- Generate and interpret data visualizations from sensor readings
- Debug logic errors in automated systems

Unit Title: Motion Control & Mechanical Integration

Big Idea: *How do we create systems that interact physically with their environment?*

Activities & Projects

- Control servos and motors for precise movement
- Build a "waving bot" or sensor-triggered motion system
- Design robot arms or sensor mounts in Fusion 360
- Learn mechanical joints, constraints, and movement in CAD
- Create input/output logic chains for complex behaviors

CPI

- 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact.
- 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.NT.2: Analyze an existing technological product that has been repurposed for a different function.
- 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.

Vocabulary (One Sentence)

- **Actuator** - Device that converts electrical signals into physical movement
- **Servo** - Motor with precise position control and feedback
- **Mechanical** - Related to physical forces, motion, and machinery
- **Joint** - Connection point that allows movement between parts
- **Constraint** - Rule that limits or defines mechanical relationships
- **Kinematics** - Study of motion without considering forces
- **Torque** - Rotational force that causes objects to turn

Unit Enduring Understandings

- Physical intelligence requires coordination between sensing, decision-making, and mechanical action
- Mechanical design principles determine how effectively systems can interact with their environment
- Precise control of motion enables robots to perform complex, useful tasks

Unit Objectives: Students will know...

- Different types of actuators and their appropriate applications
- How servo motors provide precise position control
- Basic principles of mechanical design for robotic systems
- The relationship between CAD design and physical manufacturing constraints
- How input/output chains create complex automated behaviors

Unit Objectives: Students will be able to...

- Program servo motors for precise position control
- Design mechanical systems using joints and constraints in Fusion 360
- Create systems that combine sensing with physical movement
- Build prototypes that integrate 3D printed parts with electronic control
- Troubleshoot mechanical and electrical integration issues

Unit Title: Systems Integration & Data Intelligence

Big Idea: *How do we combine multiple technologies to create comprehensive intelligent solutions?*

Activities & Projects

- Design and build a "Smart Desk Helper" combining CAD and code
- Implement data logging to record sensor values over time
- Save sensor data to CSV files for analysis
- Explore data patterns and their significance
- Create integrated prototypes with multiple sensors and actuators

CPI

- 8.1.8.CS.2: Design a system that combines hardware and software components to process data.
- 8.1.8.CS.3: Justify design decisions and explain potential system trade-offs.
- 8.2.8.ED.5: Explain the need for optimization in a design process.
- 8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose.

Vocabulary (One Sentence)

- **Integration** - Combining different systems to work together seamlessly
- **Data Logging** - Recording information over time for later analysis
- **CSV** - Comma Separated Values file format for data storage
- **Pattern** - Recurring trends or behaviors in data or systems

- **Database** - Organized collection of stored information
- **Prototype** - Working model built to test integrated system concepts
- **Validation** - Process of confirming that systems work as intended

Unit Enduring Understandings

- Intelligent systems become more powerful when multiple technologies are thoughtfully integrated
- Data collection and analysis enable systems to learn from past behavior and improve performance
- Successful integration requires careful planning and systematic testing

Unit Objectives: Students will know...

- Strategies for combining mechanical, electrical, and software components
- Methods for collecting, storing, and analyzing time-series data
- The importance of data in creating adaptive and learning systems
- How to validate that integrated systems meet design requirements
- Common challenges in systems integration and approaches to solve them

Unit Objectives: Students will be able to...

- Design and build integrated systems combining multiple technologies
- Implement data logging systems that capture sensor information over time
- Analyze collected data to identify patterns and trends
- Create CSV files for data export and external analysis
- Test and validate integrated system performance against design goals

Unit Title: Artificial Intelligence & Human-Centered Design

Big Idea: *How do we create intelligent systems that serve human needs ethically and effectively?*

Activities & Projects

- Explore machine learning using Teachable Machine or similar tools
- Discuss ethics in AI and responsible technology development
- Conduct user interviews and create empathy maps for capstone projects
- Design storyboards showing human-system interactions
- Practice pattern recognition and supervised learning concepts

CPI

- 8.1.8.DA.2: Explain the difference between how the computer stores data as bits and how the data is displayed.
- 8.1.8.DA.3: Identify the appropriate tool to access data based on its file format.
- 8.1.8.IC.1: Compare the trade-offs associated with computing technologies that affect individual’s everyday activities and career options.
- 8.1.8.IC.2: Describe issues of bias and accessibility in the design of existing technologies.
-

Vocabulary (One Sentence)

- **Artificial Intelligence** - Computer systems that can perform tasks typically requiring human intelligence
- **Machine Learning** - AI method where systems improve through experience with data
- **Ethics** - Moral principles that guide responsible technology development
- **Empathy** - Understanding and sharing the feelings of others
- **Storyboard** - Visual sequence showing user interactions with systems
- **Bias** - Unfair prejudice in AI systems or data
- **User Experience** - Overall experience a person has using a system

Unit Enduring Understandings

- Responsive systems use sensors to gather information about their environment and react accordingly
- The integration of inputs and outputs creates interactive experiences
- Real-time feedback improves user experience and system effectiveness

Unit Objectives: Students will know...

- The difference between analog and digital signals
- How various sensors detect environmental conditions
- Methods for controlling motors and actuators
- How to process and respond to multiple inputs simultaneously
- The importance of timing in interactive systems

Unit Objectives: Students will be able to...

- Program systems that respond to sensor input
- Create interactive games using physical controls
- Control servo motors and LED arrays programmatically
- Integrate multiple inputs to create complex behaviors
- Design user interfaces that provide clear feedback

Unit Title: Advanced System Design & Project Planning

Big Idea: *How do we plan and design complex intelligent systems that solve real-world problems?*

Activities & Projects

- Teams finalize intelligent system concepts for capstone projects
- Create detailed system diagrams and technical flowcharts
- Develop project timelines and define team member roles
- Design mechanical components that support system functionality
- Plan integration strategies for sensors, actuators, and AI components

CPI

- 8.2.8.ED.1: Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
- 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.
- 8.2.8.ED.5: Explain the need for optimization in a design process.
- 8.2.8.ED.6: Analyze how trade-offs can impact the design of a product.
- 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

Vocabulary (One Sentence)

- **Architecture** - Overall design structure of a complex system
- **Specification** - Detailed description of system requirements and features
- **Flowchart** - Visual representation of system processes and decisions
- **Documentation** - Written records of design decisions and technical details
- **Milestone** - Important checkpoint in project development timeline
- **Scalability** - Ability of a system to handle increased demands
- **Optimization** - Process of making systems as efficient as possible

Unit Enduring Understandings

- SComplex intelligent systems require careful planning and systematic design approaches
- Effective project management balances technical requirements with time and resource constraints
- Clear documentation and communication are essential for successful team-based engineering projects

Unit Objectives: Students will know...

- Methods for planning complex technical projects with multiple components
- How to create system diagrams that communicate design concepts clearly
- Strategies for dividing complex projects into manageable tasks
- The importance of documentation in engineering design processes
- How to balance ambitious goals with realistic project constraints

Unit Objectives: Students will be able to...

- Create comprehensive system diagrams for intelligent system designs
- Develop realistic project timelines with clear milestones
- Work effectively in teams with defined roles and responsibilities
- Document design decisions and technical specifications
- Plan integration strategies for complex multi-component systems

Unit Title: Capstone Implementation & Showcase

Big Idea: *HHow do we bring intelligent system designs to life and communicate their value to others?*

Activities & Projects

- Full implementation of capstone intelligent system projects
- Integration of all semester technologies: sensors, actuators, AI, 3D design, and programming
- Iterative testing, debugging, and system refinement
- Public presentation and demonstration of working prototypes
- Peer feedback sessions and reflective analysis of learning journey

CPI

- 8.1.8.AP.6: Refine a solution that meets users' needs by incorporating feedback from team members and users.
- 8.1.8.AP.7: Design programs, incorporating existing code, media, and libraries, and give attribution.
- 8.1.8.AP.8: Systematically test and refine programs using a range of test cases and users.
- 8.1.8.AP.9: Document programs in order to make them easier to follow, test, and debug.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.
- 8.2.8.ED.5: Explain the need for optimization in a design process.
- 8.2.8.ED.6: Analyze how trade-offs can impact the design of a product.
- 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

Vocabulary (One Sentence)

- **Implementation** - Process of building and deploying a designed system
- **Debugging** - Finding and fixing problems in hardware or software
- **Demonstration** - Showing how a system works to an audience
- **Iteration** - Repeated cycles of testing and improvement
- **Presentation** - Formal communication of project results and insights
- **Portfolio** - Collection of work showing learning and growth
- **Innovation** - Creating novel solutions to existing problems

Unit Enduring Understandings

- Successful intelligent systems require integration of multiple engineering disciplines and iterative refinement
- Effective technical communication helps others understand and build upon engineering innovations

● Reflection on the engineering design process leads to improved problem-solving skills and deeper learning
Unit Objectives: Students will know... ● Strategies for managing complex technical projects from concept to completion ● Methods for testing and validating intelligent system performance ● Effective techniques for presenting technical work to diverse audiences ● The value of peer feedback in improving engineering solutions ● How their learning connects to current trends in technology and engineering
Unit Objectives: Students will be able to... ● Build functional intelligent systems that integrate multiple technologies ● Debug and troubleshoot complex hardware and software issues ● Present technical projects clearly and persuasively to audiences ● Provide constructive feedback on peer engineering projects ● Reflect critically on their engineering design process and identify areas for future growth