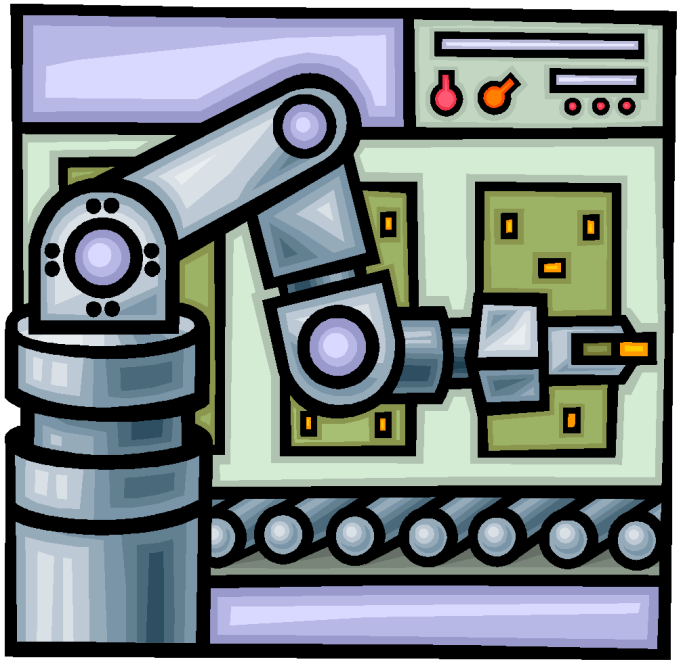
Hamilton Township School District
90 Park Avenue
Hamilton, New Jersey 08690
Mercer County

Department of Curriculum and Instruction



Electronics and Robotics II
Grades 10 – 12

Board of Education approved:

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Acknowledgements

Administration

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Mr. Anthony Scotto	Director of Curriculum & Instruction
Mr. Matthew Sisk	Supervisor, Science & Applied Technology 6-12

Committee Members

Steven Pae	Hamilton High School East
Gregory Paulick	Hamilton High School West
Scott Innocenzi	Hamilton High School North

Introduction

This guide has been prepared to meet the requirements of the Hamilton Township Board of Education and the New Jersey Department of Education. This document will serve as a guide for lesson planning. It sets forth a framework upon which each school can build a program suited both to the needs of the students and to the expectations of the community.

Course Description

Electronics and Robotics II is designed to expand upon the fundamental principles of electricity, electronics and robotics which were covered in the introductory course.

Students will enhance their knowledge of the instruments, measurements and circuitry involved with this area of technology. They will assemble increasingly complex electronic systems that will test and reinforce their knowledge. The building of an elaborate robotic device will culminate their learning experience.

Pacing Guide		
Unit	**Core Ideas and Standards**	**Approximate Number of Days**
Unit 1: Electricity and Electronics	**Connections to Engineering, Technology, and Applications of Science** ● Interdependence of Science, Engineering & Technology: o Science & engineering complement each other in the cycle known as research and development (R & D) o Many R & D projects involve scientists, engineers, and others with wide ranges of expertise. ● Influence of Science, Engineering & Technology on Society and the World: o Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. o Engineers continuously modify these systems to increase benefits while decreasing costs and risks. o New technologies can have deep impacts on society and the environment, including some that were not anticipated. o Analysis of costs and benefits is a critical aspect of decisions about technology. **Connections to the Nature of Science:** ● Science and engineering are influenced by society, and society is influenced by science and engineering. **ETS1.A: Defining and Delimiting Engineering Problems:** ● Humanity faces major global challenges today, such as the need for supplies of clean water and food, or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. **ETS1.B: Developing Possible Solutions:** ● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways to solve a problem or to see which one is more efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2) **Career & Technical Education Cluster 9.3** Science, Technology, Engineering & Math ● 9.3ST4: Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy. ● 9.3ST-ET.1: Use STEM concepts and processes to solve problems involving design and/or production ● 9.3ST-ET.3: Apply processes and concepts for the use of technological tools in STEM.	15days

	• 9.3ST-ET.5: Apply the knowledge learned in STEM to solve problems. • 9.3ST-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. **PS2.B Types of Interactions** • Attraction and repulsion between electric charges at the atomic scale explain the structure, properties and transformations of matter, as well as the contact forces between material objects. • Forces at a distance are explained by fields (gravitational, electric and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields, electric charges or changing magnetic fields cause electric fields **PS3: Energy** • Energy is a quantitative property of a system that depends on the motion and interaction of matter and radiation within that system. • At the macroscopic level energy manifests itself in multiple ways, such as in motion. Sound, light and thermal energy. • Electrical energy may mean energy stored in a battery or energy transmitted by electric currents	
Unit 2: Semiconductors and Power Supplies	**Connections to Engineering, Technology, and Applications of Science** • Interdependence of Science, Engineering & Technology: o Science & engineering complement each other in the cycle known as research and development (R & D) o Many R & D projects involve scientists, engineers, and others with wide ranges of expertise. • Influence of Science, Engineering & Technology on Society and the World: o Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. o Engineers continuously modify these systems to increase benefits while decreasing costs and risks. o New technologies can have deep impacts on society and the environment, including some that were not anticipated. o Analysis of costs and benefits is a critical aspect of decisions about technology. **Connections to the Nature of Science:** • Science and engineering are influenced by society, and society is influenced by science and engineering. **ETS1.A: Defining and Delimiting Engineering Problems:** • Humanity faces major global challenges today, such as the need for supplies of clean water and food, or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. **ETS1.B: Developing Possible Solutions:** • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test	15 days

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Unit 3: Tubes, Transistors and Amplifiers	**Connections to Engineering, Technology, and Applications of Science** ● Interdependence of Science, Engineering & Technology: o Science & engineering complement each other in the cycle known as research and development (R & D) o Many R & D projects involve scientists, engineers, and others with wide ranges of expertise. ● Influence of Science, Engineering & Technology on Society and the World: o Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. o Engineers continuously modify these systems to increase benefits while decreasing costs and risks.	15 days

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Unit 4: Integrated and Digital Circuits	**Connections to Engineering, Technology, and Applications of Science** ● Interdependence of Science, Engineering & Technology: o Science & engineering complement each other in the cycle known as research and development (R & D) o Many R & D projects involve scientists, engineers, and others with wide ranges of expertise. ● Influence of Science, Engineering & Technology on Society and the World: o Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. o Engineers continuously modify these systems to increase benefits while decreasing costs and risks. o New technologies can have deep impacts on society and the environment, including some that were not anticipated. o Analysis of costs and benefits is a critical aspect of decisions about technology. **Connections to the Nature of Science:** ● Science and engineering are influenced by society, and society is influenced by science and engineering. **ETS1.A: Defining and Delimiting Engineering Problems:** ● Humanity faces major global challenges today, such as the need for supplies of clean water and food, or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. **ETS1.B: Developing Possible Solutions:** ● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways to solve a problem or to see which one is more efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2) ● **Career & Technical Education Cluster 9.3** Science, Technology, Engineering & Math ● 9.3ST4: Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy. ● 9.3ST-ET.1: Use STEM concepts and processes to solve problems involving design and/or production ● 9.3ST-ET.3: Apply processes and concepts for the use of technological tools in STEM. ● 9.3ST-ET.5: Apply the knowledge learned in STEM to solve problems. ● 9.3ST-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. **PS2.B Types of Interactions**	20 days

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Unit 5: Robotics	**Connections to Engineering, Technology, and Applications of Science** • Interdependence of Science, Engineering & Technology: o Science & engineering complement each other in the cycle known as research and development (R & D) o Many R & D projects involve scientists, engineers, and others with wide ranges of expertise. • Influence of Science, Engineering & Technology on Society and the World: o Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. o Engineers continuously modify these systems to increase benefits while decreasing costs and risks. o New technologies can have deep impacts on society and the environment, including some that were not anticipated. o Analysis of costs and benefits is a critical aspect of decisions about technology. **Connections to the Nature of Science:** • Science and engineering are influenced by society, and society is influenced by science and engineering. **ETS1.A: Defining and Delimiting Engineering Problems:** • Humanity faces major global challenges today, such as the need for supplies of clean water and food, or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. **ETS1.B: Developing Possible Solutions:** • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways to solve a problem or to see which one is more efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2) • **Career & Technical Education Cluster 9.3**	115 days

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Unit 1 : Electricity and Electronics

Essential Questions:

- How do technicians represent circuits?
- What are the key foundation skills needed to develop advanced skills in electronics?

Student Learning Objectives:

By the end of the unit the student will be able to:

- list and diagram the parts of a circuit.
- state and explain the law of electrical charges, providing multiple examples.
- define key electrical terms: voltage, current, resistance, load, potential, conductor, insulator, semiconductor, and coulomb.
- differentiate between direct current and alternating current.
- compare concepts of series and parallel circuits.
- state, explain, and solve problems utilizing Ohm's Law.
- compare analog and digital meters.
- apply Ohm's Law to solve unknown voltage, current, and resistance in a series circuit.
- apply Ohm's Law to solve for unknown voltage, current, and resistance in a parallel circuit.
-

NJSLS:

PS2.B Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties and transformations of matter, as well as the contact forces between material objects.
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PS3: Energy

- Energy is a quantitative property of a system that depends on the motion and interaction of matter and radiation within that system.
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Suggested Learning Activities:

- Experiment- “The electronic switch”
- Practice - Build a circuit from a diagram and meter it
    - Project - Design a circuit to have specific measurements at specific points

Evidence of Learning:

Formative:	**Summative:**
● Admit/Exit Tickets ● Questions, Questioning, and Discussions ● Visual modeling of concepts ● Project notebooks	● Performance assessments demonstrating safe use of machines and tools ● Quizzes/Tests ● Projects/Presentations

Unit 2 : Semiconductors and Power Supplies - (Combine with Unit 3 and replace Unit 3 w/ AI?)

Essential Questions:

- What is electronics?
- How do active devices promote the flow of electrons?
- What techniques and materials do technicians use to control the flow of electricity?

Student Learning Objectives:

By the end of the unit the student will be able to:

- define electronics.
- explain the doping process, including how N-type and P-type materials are made.
- explain forward and reverse biasing.
- describe various types of semiconductor diodes.
- describe power supply load characteristics.

NJSLS:

PS2.B Types of Interactions

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Suggested Learning Activities:

- Project- “Power supply”

Evidence of Learning:	
Formative: ● Admit/Exit Tickets ● Questions, Questioning, and Discussions ● Visual modeling of concepts ● Project notebooks	**Summative:** ● Performance assessments demonstrating safe use of machines and tools ● Quizzes/Tests ● Projects/Presentations

Unit 3 : Tubes, Transistors and Amplifiers

Essential Questions:

- How did electrical devices evolve?
- What is a transistor?
- What electrical devices use a transistor?

Student Learning Objectives:

By the end of the unit the student will be able to:

- list the use of transistors.
- describe the use of thyristors, including the integrated circuit

NJSLS:

PS2.B Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties and transformations of matter, as well as the contact forces between material objects.
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Suggested Learning Activities:

- Project – Building a sensor controlled robot
- H-Bridge Motor Controller
- Experiment - Logic Gates
- Project - Chaining Logic Gates together
- Model a logical scenario using logical terms and operations

Evidence of Learning:

~~**Formative:**~~	~~**Summative:**~~
~~● Admit/Exit Tickets~~ ~~● Questions, Questioning, and Discussions~~ ~~● Visual modeling of concepts~~ ~~● Project notebooks~~	~~● Performance assessments demonstrating safe use of machines and tools~~ ~~● Quizzes/Tests~~ ~~● Projects/Presentations~~

Unit 3 : Integrated and Digital Circuits

Essential Questions:

- What are the two primary functions of an electronic amplifier device?
- What is the difference between a linear and digital integrated circuit?
- What role does digital electronics play in everyday life?
- What is the relationship between digital electronics and the binary number system?
- What models are used to represent digital relationships?
- What is a circuit board?
- How do technicians use circuit boards?
- What are the procedures for etching a circuit board?

Student Learning Objectives:

By the end of the unit the student will be able to:

- describe the history of the integrated circuit.
- compare linear and digital integrated circuits.
- describe advantages of an operational amp.
- describe advantages of timers, function generators and voltage regulators.
- describe and apply the binary system.
- list the seven different logic gates and their symbols
- layout a basic circuit on a breadboard.
- transfer circuit to a printed circuit.
- incorporating safety procedures, etch a circuit board.

NJSLS:

PS2.B Types of Interactions

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Suggested Learning Activities:

- Project – Building Historical timeline of integrated circuit
- Project – Building a voice recorder
- Project – Building an Audio Amplifier
- Experiment - Logic Gates
- Project - Logic Gates utilized to model a real world logic scenario
- Writing base ten numbers in their binary form
    - Project- Binary Encoder?

Evidence of Learning:

Formative:	**Summative:**
● Admit/Exit Tickets ● Questions, Questioning, and Discussions ● Visual modeling of concepts ● Project notebooks	● Performance assessments demonstrating safe use of machines and tools ● Quizzes/Tests ● Projects/Presentations

Unit 4: Artificial Intelligence

Essential Questions:

- What is Artificial Intelligence?
- How does Artificial Intelligence affect our daily lives?
- How can we use Artificial Intelligence to address problems normal computing struggles with?
- How does the quality and quantity of data affect the results of ML/AI?

Student Learning Objectives:

By the end of the unit the student will be able to:

- Identify the usage of AI in the world
- Utilize proper vocabulary when identify and classifying AI
- Interact with consumer-facing AI and describe its functions

NJSLS:

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

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.

Suggested Learning Activities:

- Activity- ChatBots + Consumer-facing AI
- Investigation- Social Media Algorithms + AI in the wild
- Project - Gather data and train an AI
-

Evidence of Learning:

Formative:	**Summative:**
● Admit/Exit Tickets ● Questions, Questioning, and Discussions ● Visual modeling of concepts ● Project notebooks	● Performance assessments demonstrating safe use of machines and tools ● Quizzes/Tests ● Projects/Presentations

Unit 5 : Robotics

Essential Questions:

- What are the components of a basic robot?
- How do you write a robotics design plan?
- What are effective troubleshooting techniques?
- What are the design constraints?
- What is the design plan?
- What materials are available?

Student Learning Objectives:

By the end of the unit the student will be able to:

- practice soldering techniques.
- use design engineering principles to develop a robot for competition within instructor established criteria utilizing packaged robotic kit.
- create a robot that monitors sensors to detect the world around it; make decisions on what it senses; control its motion; and exchange information with the operator.
- design, construct and test a unique robot.

NJSLS:

Suggested Learning Activities:

- Experiment- “Resistors in series”

Vex V5 Stem Lab lessons

Vex VR (Remote) Vex Code (In-Person)

Pitsco Tetrix

Evidence of Learning:

Formative:	**Summative:**
● Admit/Exit Tickets ● Questions, Questioning, and Discussions	● Performance assessments demonstrating safe use of machines and tools ● Quizzes/Tests ● Projects/Presentations

• Visual modeling of concepts • Project notebooks	

Instructional Modifications	
Special Education Modified test items as needed Allow extended time on assessments Provide oral assessments Assist students in preparing study guides Allow use of references cards Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).	**504** In addition to services noted in the students' 504 plans, other modifications may include, but are not limited to the following Written directions that correspond to online directions. Visual and verbal instruction. One on one demonstration of model. Chunk assignments Create predictable classroom routines Provide sensory breaks Set time expectations for assignments Highlight main ideas and supporting details in the book Provide seating options Tolerate (understand the need) excessive movement

Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. Use project-based science learning to connect science with observable phenomena. Structure the learning around explaining or solving a social or community-based issue. Collaborate with after-school programs or clubs to extend learning opportunities	
Students at Risk: After school tutoring I & RS Model the tasks Provide direct and uncomplicated directions Repeat, clarify and re-word directions where needed. Maintain home –school communication. Accept late work without penalty Provide task lists for organization Maintain high expectations for learning Teach organizational and study skills Allow for breaks and movement in the class Increase one on one instruction time Use consistent formats for tests, quizzes etc.	**Gifted & Talented:** Enhanced expectations for deeper/extended understanding Projects that extend the basic unit concepts Peer tutoring Cooperative learning groups Modified assignments Extension activities Opportunities for Critical Thinking Problem Solving/Design Challenges Technology Integration Student Choice Activities The use of more advanced or complex concepts

ELL Accommodations & Modifications

Categories of Scaffolds	Examples
Materials and Resources	Graphic organizers English and/or bilingual dictionaries Home language materials Sentence frames, sentence stems, and paragraph frames Visuals Word banks and word walls
Instruction	Pre-identified and pre-taught academic vocabulary Building background knowledge Activating prior knowledge Reduced linguistic load Repetition, modeling, and paraphrasing
Student Grouping	Structured pair work Structured small group work Teacher-led small group work

ESL Scaffolding at Varying Proficiency Levels

ELP Level	Scaffolds for Instruction by Level	Scaffolds for All Levels
Beginning ELP 1.0-2.5	Access to text, video. and/or instructions in home language, as well as in English Sentence frames to help ELLs respond to test-dependent questions posed throughout the lesson Word walls and word banks Reduced linguistic load for language of instruction	Building background knowledge Activating prior knowledge Pre-taught academic vocabulary Hands-on materials and manipulatives Graphic organizers Word-to-Word Dictionaries Wait Time
Intermediate ELP 2.5-4.0	Access to text, video. and/or instructions in home language, as well as in English, as appropriate Sentence stems Word walls and word banks	

Advanced Above ELP 4.1	See scaffolding for all levels	Repetition, paraphrasing, and modeling Pair and small-group work

Additional Supports

~ Core5, PowerUp, and Rosetta Stone ~ Sheltered English Instruction Training

~ K - 12th grade tutoring

Interdisciplinary Connections: NJSLS Language Arts Literacy (Companion Standards)

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Interdisciplinary Connections: NJSLS Mathematics

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Integration of Technology through NJSLS

8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

8.2.12.NT.2: Redesign an existing product to improve form or function.

8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.

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.

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.

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).

8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).

Integration of 21st Century Skills though NJSLS 9/Career Education

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.

9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.

9.2.12.CAP.7: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities

9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition

9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Career Opportunities:

Students can be introduced to potential career options that include:

Core Instructional & Supplemental Materials

Electricity and Electronics - Goodheart-Wilcox Co.

Additional Resources

Safety information sheets.

www.osha.gov
www.mrs.fixit.com