HILLSBOROUGH TOWNSHIP SCHOOL DISTRICT

HILLSBOROUGH HIGH SCHOOL

APPLIED TECHNOLOGY CURRICULUM

ENERGY & POWER TECHNOLOGY

AUGUST 2020

This curriculum was approved by the Hillsborough Township Public Schools Board of Education on September 21, 2020.

Energy & Power Technology
Course Overview

In Energy and Power Technology, students engage in practical experiences with various systems that produce energy and power. General shop, laboratory and tool safety will be covered. Simple machines, electricity and electronics are studied as sources of power generation and control systems. Alternative sources of energy (solar, wind, hydroelectric, etc.), transportation technologies and the environmental implications of these technologies are addressed. The disassembly, study, and reassembly of an internal combustion engine provide students with a foundation to examine other forms of energy production. Throughout the semester, students work independently and in groups to learn course concepts through a series of hands-on problem-solving experiences.

***Energy & Power Technology is the prerequisite to Energy & Power Technology II.*

2020 HTPS Applied Technology Curriculum Map – Energy & Power Technology

Unit of Study	Pacing	NJ Student Learning Standards	Essential Questions	Enduring Understandings	Learning Targets	Assessment: Formative & Summative	Interdisciplinary Connections	Career Readiness, Life Literacies, & Key Skills Standards
Unit 1- Energy	2-4 days 18 weeks Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ-Career & Technical Education (CTE) Standards* 9.3.HT-TT.2 Apply unit and time conversion skills to develop travel schedules and compute cost, distance, and time (including travel time) factors. *Computer Science & Design Thinking Ethics & Culture* 8.2.12. EC.1: Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made. 8.2.12. EC.2: Assess the positive and negative impacts of emerging	What is energy? What are the two types of energy? How do you describe the relationship between work, energy, and power? How do you represent the relationships between the three, using mathematical formulas? What is the relationship between power in kW and in horsepower? What is efficiency? Can energy be created or destroyed?	Energy is the ability to do work. Understanding and demonstrating the relationship between: • Work is the transferring and transformation of energy. • Power is the rate at which work is being done.	The student will be able to define and contrast energy, work, and power. Given mass, distances, and time, students will be able to calculate horsepower and power using appropriate units. Given the conversion formulas, students will be able to calculate horsepower and kilowatt equivalence. Students will be able to apply measurement tools to apply the concepts of work, power, and energy to a real-life example.	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures. Engineering Notebook Quiz (es)	*From Molecules to Organisms: Structures & Processes* HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Develop and use models to illustrate that energy at the	*Information & Media Literacy* 9.4.12.IML.1: Compare search browsers and recognize features that allow for filtering of information. 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. 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design

		technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.			Students will be able to calculate efficiency. Students will be able to define the following terms: • Force • Joule • Energy • Work • Power • Meter • Kilogram • Btu • Kilowatt • Horsepower • Efficiency Students will be able to discuss energy and the relationship to power and work. Students will be able to discuss renewable and non-renewable energy sources. Students will be able to calculate energy, power, and work on mechanical and electrical systems.	Unit Test(s) Unit Project Successful completion of safety test and assignments	macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the	solutions (e.g., S-ID.B.6a., 8.1.12. DA.5, 7.1.IH. IPRET.8) 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).

							components in the system (second law of thermodynamics). HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. Motion & Stability: Forces & Interactions HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 Apply scientific and engineering ideas	

							to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	

Unit of Study	Pacing	NJ Student Learning Standards	Essential Questions	Enduring Understandings	Learning Targets	Assessment: Formative & Summative	Interdisciplinary Connections	Career Readiness, Life Literacies, & Key Skills Standards
Unit 2- General Tools, Measurements and Material Processing	1 week 18 Weeks Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ-Career & Technical Education (CTE) Standards* 9.3.MN-MIR.1 Demonstrate maintenance skills and proficient operation of equipment to maximize manufacturing performance. 9.3.MN-MIR.2 Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment. 9.3.MN-MIR.3 Diagnose equipment problems and effectively repair manufacturing equipment. 9.3.MN-MIR.4 Investigate and employ techniques to maximize manufacturing equipment performance.	What tools are used to process materials and what are steps to operate hand tools safely? What tools serve to process wood and materials based on production needs? How are materials fastened and how what applications can each type be used in? What are the proper ways to read and utilize a ruler for various processing environments? What are the two common	Tools and equipment will be demonstrated and applied on project designs. SI prefixes, also known as a metric prefix, have names and symbols that precedes a unit of measure or its symbol to form decimal multiples. SI prefixes are used to reduce the quantity of zeroes in numerical equivalencies.	Students will be able to explain why quality tools and measuring instruments should be used. Students will be able to use common hand tools properly. Students will be able to demonstrate ways to process materials. Students will be able to use wood and other common materials to assemble projects. Students will be able to demonstrate the proper use of shop tools and equipment.	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology	HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios	*Technology Literacy* 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.). 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

		9.3.MN-MIR.5 Implement a preventative maintenance schedule to maintain manufacturing equipment, tools, and workstations. 9.3.MN-MIR.6 Implement an effective, predictive, and preventive manufacturing equipment maintenance program. *Computer Science & Design Thinking Engineering Design* 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).	measurement systems? What are the seven base units in the SI system and how is each best utilized? What institution adopted the metric system as the standard for all engineering and scientific literature? How is a number expressed in scientific notation and how is that relevant in processing?		Students will be able to demonstrate the proper way to read a ruler. Students will be able to define the following terms: • Hammers • Files • Saws • Drilling • Sanding • Power Tools • Glue Guns • Soldering Iron • Routers • Modeling tools • Other tools as needed. • Exa • Peta • Tera • Giga • Mega • Kilo • Milli • Micro • Nano • Pico • Femto • Atta	and procedures. Engineering Notebook Quiz (es) Unit Test(s) Unit Project Successful completion of safety test and assignments		

		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).			Students will be able to differentiate between fundamental units and derived units. Students will be able to demonstrate knowledge of the SI system of measurements. Students will be able to write numbers in scientific and engineering notation. Students will be able to recognize and properly use the symbols for SI prefixes. Students will be able to describe the advantage of engineering notation for use in electronics. Students will be able to			

					convert SI prefixes from one form to another. Students will be able to utilize the calculator for entering numbers in engineering notation. Students will be able to apply prefix conversion to given problems.			

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Unit 3- Mechanical Energy and Simple Machines	2-3 weeks Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ-Career & Technical Education (CTE) Standards* 9.3.12.AC-CST.9 Safely use and maintain appropriate tools, machinery, equipment, and resources to accomplish construction project goals. *Computer Science & Design Thinking Engineering Design* 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.2: Create scaled engineering drawings for a new product or system and make modification to	What are the different simple machines? What is mechanical energy? What are the different types of levers and what are their applications?	Machines, both simple and compound, make our everyday work easier for humans. There are six types of simple machines (lever, screw, pulley, wheel and axle, inclined plane, and wedge. Work is done when objects move in the direction of the applied force.	Students will be able to explain simple machine operation. Students will be able to list the different simple machines and how they are utilized. Students will be able to define the difference between load and force. Students will be able to identify the basic components of simple machines and describe the function of each part. Students will be able to use mechanical	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures. Engineering Notebook	*Engineering Design* HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost,	*Creativity & Innovation* 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1. 12prof.CR3a). 9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4. 12prof.CR2b, 2.2.12.LF.8). 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1). *Critical Thinking & Problem Solving* 9.4.12. CT.1: Identify problem-solving strategies used in the development of an innovative product or

		increase optimization based on feedback. 8.2.12. ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. 8.2.12. 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.			energy to move an object. Students will be able to calculate forces applied to an object. Students will be able to design a product that uses simple machines.	Quiz (es) Unit Test(s) Unit Project Successful completion of safety test and assignments	safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	practice (e.g., 1.1. 12acc.C1b, 2.2.12. PF.3). 9.4.12. CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1. 3E.12profCR3.a). 9.4.12. CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service-learning activity that addresses a local or global issue (e.g., environmental justice). 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.

Unit of Study	Pacing	NJ Student Learning Standards	Essential Questions	Enduring Understandings	Learning Targets	Assessment: Formative & Summative	Interdisciplinary Connections	Career Readiness, Life Literacies, & Key Skills Standards
Unit 4- Electricity	1 week 18 weeks Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ Science - Waves and their Applications in Technologies for Information Transfer* HS-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.	What is matter? Why is the valence electron important when understanding electricity? What does the placement of the 29 electrons of the copper atom have to do with its electrical properties? What are the differences between conductors, semiconductors, and insulators? Why doesn't an orbiting electron fall into the nucleus of the atom? What is the difference between the charge of an electron and a coulomb?	Electrons on the outer most shell of the atomic structure of an element have a significant role in the flow of electrons (current). Schematic diagrams and symbols show the representation of various electronic components and movement of electricity. A complete circuit requires a voltage source, load, controller, and path for electricity.	Students will be able to define common terms associated with atomic properties. Students will be able to differentiate between a molecule and a compound. Students will be able to describe the makeup of atoms via subatomic particles. Students will be able to compare and contrast the various energy levels within the atom and the basis for existence in the energy levels. Students will be able to identify the valence shell and state its	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures. Engineering Notebook	*From Molecules to Organisms: Structures & Processes* HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. Energy HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Develop and use models to illustrate that	*Career Awareness and Planning* 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.3: Investigate how continuing education contributes to one's career and personal growth. 9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

			How is voltage, current, and resistance calculated and applied? Why are schematic symbols and diagrams used? What constitutes a series circuit and how is it used? What does component dependency mean in a series of strung lights? How is total resistance found in a series circuit? How do the three characteristics of a series circuit effect its functionality? What are various forms of troubleshooting?		importance to understanding electricity. Students will be able to compare and contrast the terms conductors, semiconductors, and insulators. Students will be able to define the following terms: • Matter • Atom • Element • Compound • Valence shell • Conductor • Insulator • Voltage • Current • Resistance • Power • Circuits • Schematics • Resistance • Conductance • Voltage Drop Students will be able to illustrate the structure of given elements and show their	Quiz (es) Unit Test(s) Unit Project Successful completion of safety test and assignments	energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution	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. 9.2.12.CAP.8: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. *Technology Literacy* 9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments. 9.4.12.TL.4: Collaborate in online learning communities

					subatomic particles. Students will be able to give example of conductors, insulators, and semiconductors. Students will be able to discuss the Law of Charges. Students will be able to create a project using magnetic and electrical properties. Students will be able to define voltage in terms of work and charge. Students will be able to compare and contrast potential difference and voltage. Students will be able to describe the conditions needed for electron flow.		among the components in the system (second law of thermodynamics). HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. Motion & Stability: Forces & Interactions HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-3 Apply scientific and	or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL. IPERS.6).

					Students will be able to describe a voltage drop. Students will be able to describe how current is measured. Students will be able to describe the factors that affect resistance. Students will be able to construct a practical electric circuit. Students will be able to use a breadboard, wires, LEDs, battery, and motor to discuss the electrical quantities. Students will be able to apply Ohm's Law to real-world applications. Students will be able to state the rules for a series-connected circuit. Students will be able to solve for		engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	

					circuit and component resistance, voltage, current, and power. Students will be able to determine voltage polarity using a variety of notations. Students will be able to compare the terms ground, common, and reference. Students will be able to differentiate between open and shorts in series circuits. Students will be able to describe the purpose of using resistors in an electrical circuit. Students will be able to build a simple electrical circuit and apply components to merge into a series circuit.			

					Students will be able to identify schematic symbols and components. Students will be able to illustrate a schematic diagram of a series circuit, label components, and calculate unknown quantities.			

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Unit 5- Energy Types	3-4 Weeks Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*Computer Science & Design Thinking Engineering Design* 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,	What are applications of solar energy? What are applications of wind energy? What are applications of hydroelectric energy? How is energy used?	Renewable and non-renewable energy sources are used to address human needs and improve standard of living. Energy conservation and energy efficiency is important for sustainability.	Students will be able to learn about photovoltaic applications. Students will be able to learn about turbine and blade design. Students will be able to learn about generator design. Students will be able to select one of the alternative energy sources and devise a device to generate and utilize electricity.	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures. Engineering Notebook	*From Molecules to Organisms: Structures & Processes* HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. *Ecosystems: Interactions, Energy, and Dynamics* HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. *Mater & Its Interactions* MS-PS1-6 Undertake a	*Career Awareness and Planning* 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.3: Investigate how continuing education contributes to one's career and personal growth. 9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

		tools, capital, labor). *Interaction of Technology & Humans* 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.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.3: Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's				Quiz (es) Unit Test(s) Unit Project Successful completion of safety test and assignments	design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.	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. 9.2.12.CAP.8: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors. *Information & Media Literacy* 9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1,

		economy, politics, and culture.						6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2). 9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5). 9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL. PRSNT.4).

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Unit 6- Transportation Technical Systems	2 to 4 weeks Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ-Career & Technical Education (CTE) Standards* 9.3.12.TD-SYS.1 Develop plans to maintain and/or improve the transportation infrastructure. 9.3.12.TD-SYS.2 Assess, plan, and manage the implementation of transportation services. 9.3.12.TD-SYS.3 Describe ways to improve the system utilization, flow, safety, and environmental performance of transportation systems. *Computer Science & Design Thinking* *Nature of Technology*	How is energy converted from one form to another? How does "degrees of freedom" relate to vehicle technical systems? Why is the framework of a transportation system important? How are internal and external combustion different?	Land, air, ground, sea, each mode of transport has a fundamentally different technological solution, and some require a separate environment.	Students will be able to define what is meant by a vehicle technical system. Students will be able to briefly explain each of the technical systems: Structure, Controls, Propulsion, Guidance, Suspension, and Support. Students will be able to identify in each transportation system the six basic technical systems. Students will be able to differentiate between	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures. Engineering Notebook Quiz (es)	*Engineering Design* HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost,	*Critical Thinking & Problem-Solving* 9.4.12. CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1. 12acc.C1b, 2.2.12. PF.3). 9.4.12. CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1. 3E.12profCR3.a). 9.4.12. CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service-learning activity that addresses a local or global issue (e.g., environmental justice).

		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. *Computer Science & Design Thinking Nature of Technology* 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. *Effects of Technology on the Natural World* 8.2.12.ETW.1: Evaluate ethical considerations regarding the			control and guidance. Students will be able to list and describe the types of support systems needed to operate a transportation vehicle or system. Students will be able to discuss the following energy conversions: external and internal combustion, mechanical, chemical, electrical. Students will be able to identify the following energy transmissions: mechanical drives, hydraulic drives, and electric drives.	Unit Test(s) Unit Project Successful completion of safety test and assignments	safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	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. *Global & Cultural Awareness* 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).

		sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product. 8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment. 8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.			Students will be able to build an ROV to reinforce unit content and understanding.			

Unit of Study	Pacing	NJ Student Learning Standards	Essential Questions	Enduring Understandings	Learning Targets	Assessment: Formative & Summative	Interdisciplinary Connections	Career Readiness, Life Literacies, & Key Skills Standards
Unit 7- Energy & Power Technologies on the Environment	1 week 18 weeks Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ-Career & Technical Education (CTE) Standards* 9.3.12.AG-ENV.1 Use analytical procedures and instruments to manage environmental service systems. 9.3.12.AG-ENV.2 Evaluate the impact of public policies and regulations on environmental service system operations. 9.3.12.AG-ENV.3 Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry, and ecology. 9.3.12.AG-ENV.4 Demonstrate the operation of environmental service systems (e.g., pollution	How do energy and power technologies affect the environment? What types of pollution do energy and power technologies produce and are there possible remediation strategies to reduce impact? How does reusing and recycling materials save money and preserve natural resources? How have energy and power technologies evolved over time?	Knowledge and understanding of human, cultural and societal values are fundamental when designing technological systems and products in the global society. Development and modification of any technological system needs to consider how the operation of the system will affect natural resources and ecosystems. Impacts of technological systems on the environment need to be monitored and must inform decision-making.	Students will learn the cultural, social, economic, and political effects of technology. Students will learn the effects of technology on the environment. Students will learn the role of society in the development and use of technology. Students will learn the influence of technology on history.	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures.	*NGSS Human Sustainability* HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-3. Create a computational simulation to illustrate the relationships	*Information & Media Literacy* 9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2). *Global & Cultural Awareness* 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-

		control, water treatment, wastewater treatment, solid waste management and energy conservation). 9.3.12.AG-ENV.5 Use tools, equipment, machinery, and technology common to tasks in environmental service systems. *Computer Science & Design Thinking Networks & the Internet* 8.1.12.NI.2: Evaluate security measures to address various common security threats. 8.1.12.NI.3: Explain how the needs of users and the sensitivity of data determine the level of security implemented. 8.1.12.NI.4: Explain how decisions on methods to protect data are influenced by whether the data	What types of unintended consequences has technology had on the environment.	Many technologies have been designed to have a positive impact on the environment and to monitor environmental change over time. The use of technology developed for the human designed world can affect the environment, including land, water, air, plants, and animals. Technologies that use natural sources can have negative effects on the environment, its quality, and inhabitants. Reusing and recycling materials can save money while preserving natural resources and		Engineering Notebook Quiz (es) Unit Test(s) Unit Project Successful completion of safety test and assignments	among the management of natural resources, the sustainability of human populations, and biodiversity. ESS3.C: Human Impacts on Earth Systems- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified	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).

		is at rest, in transit, or in use. *Computer Science & Design Thinking Impacts of Computing* 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. 8.1.12.IC.2: Test and refine computational artifacts to reduce bias and equity deficits. 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources. *Computer Science & Design Thinking Data & Analysis*		avoiding damage to the environment.			due to human activity.	

		8.1.12. DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. 8.1.12. DA.2: Describe the trade-offs in how and where data is organized and stored. 8.1.12. DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. 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. *Computer Science & Design Thinking* *Effects of Technology on the Natural World* 8.2.12.ETW.1: Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product. 8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment. 8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution. *Computer Science & Design Thinking* *Ethics & Culture*						

		8.2.12. EC.1: Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made. 8.2.12. EC.2: Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded. 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. 8.2.12.ETW.4: Research historical tensions between environmental and economic considerations as driven by human needs and						

		wants in the development of a technological product and present the competing viewpoints.						

Unit of Study	Pacing	NJ Student Learning Standards	Essential Questions	Enduring Understandings	Learning Targets	Assessment: Formative & Summative	Interdisciplinary Connections	Career Readiness, Life Literacies, & Key Skills Standards
Unit 8 – Tools & General Safety in the Small Engines Shop	1 week Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ-Career & Technical Education (CTE) Standards* 9.3. LW-EFM.5 Execute safety procedures and protocols associated with local, state, and federal regulations. 9.3. LW-EFM.7 Describe the legal, regulatory, and organizational guidelines governing emergency and fire management services. *Computer Science & Design Thinking Computing Systems* 8.1.12.CS.1: Describe ways in which integrated systems hide underlying implementation details to simplify user experiences. 8.1.12.CS.3: Compare the functions of	When working around small engines, what should you avoid wearing to prevent injury? How are fire extinguishers categorized? What is the most common cause of shop fires? What storage practices of liquids are safe? What are the correct uses of each tools, alternative applications, and applications of last resort? To remove a spark plug,	Safety in the small engines shop is fundamental to have a successful working environment. Small engines and other project designs serve as models for the application of safety procedures applicable to various projects.	Students will be able to explain why a clean, well-organized shop is extremely important. Students will be able to list several dangers associated with working in a small engine shop. Students will be able to explain the importance of maintaining and using tools properly. Students will be able to describe methods for minimizing the risks involved in working with small engines. Students will be able to explain	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures.	*Engineering Design* HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	*Civic Financial Responsibility* 9.1.12.CFR.3: Research companies with corporate governance policies supporting the common good and human rights. 9.1.12.CFR.6: Identify and explain the consequences of breaking federal and/or state employment or financial laws. *Economic & Government Influences* 9.1.12.EG.3: Explain how individuals and businesses influence

		application software, system software, and hardware.	what kind of wrench would be to use avoid damaging the plug during removal? Why is the torque wrench used in most cases? Name several types of measuring instruments used to determine if engine parts are within manufacture's tolerance.		the function of OSHA and discuss OSHA rules and regulations. Students will be able to demonstrate safety procedures within the small engine shop. Students will be able to list fire extinguisher classifications. Students will be able to explain why quality tools and measuring instruments should be used when servicing small gas engines. Students will be able to use common hand tools properly. Students will be able to summarize the reasons that small engine components	Engineering Notebook Quiz (es) Unit Test(s) Unit Project Successful completion of safety test and assignments		government policies. 9.1.12.EG.5: Relate a country's economic system of production and consumption to building personal wealth, the mindset of social comparison, and achieving societal responsibilities. 9.1.12.EG.6: Analyze the rights and responsibilities of buyers and sellers under consumer protection laws.

					must be measured carefully. Students will be able to demonstrate several of the common measuring techniques. Students will be able to demonstrate the proper use of shop tools and equipment. Students will be able to demonstrate the proper way to read and calibrate a standard micrometer. Students will be able to define the following terms: • Torque wrench • Micrometer types • Wrench • Vise grips • Pliers • Center punch			

					• Telescoping gauge • Sockets • Other tools as needed • Hazards • Solvent • Flammable • Gas • Goggles • OSHA • Toxic fumes • Carbon Monoxide • Tool Safety • Machine Safety General Safety			

Unit of Study	Pacing	NJ Student Learning Standards	Essential Questions	Enduring Understandings	Learning Targets	Assessment: Formative & Summative	Interdisciplinary Connections	Career Readiness, Life Literacies, & Key Skills Standards
Unit 9- Engine Construction and Principles of Operation	5-6 weeks (1 marking period) Embedded, discussed, introduced, integrated, and reviewed throughout all units during the semester.	*NJ-Career & Technical Education (CTE) Standards* 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	What tools are used to disassemble and assemble engine components, possible alternative uses, and uses of last resort? Name several types of measuring instruments used to determine if engine parts are within manufacture's tolerance.	The four-stroke cycle: intake, compression, power, and exhaust are the order of operation for most small engines.	Students will be able to explain simple engine operation. Students will be able to list the qualities of gasoline that make it an efficient fuel for small engines. Students will be able to explain why gasoline is atomized in the small engine. Students will be able to identify the basic components of a small engine and describe the function of each part. Students will be able to breakdown and	***Formative*** Teacher Observations Teacher questioning of student Student Progress Reports Electronic portfolio of completed assignments and projects. Rubrics will be used to assess projects. Exit Tickets ***Summative*** Teacher created assessments on terminology and procedures. Engineering Notebook	*Engineering Design* HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized	*Economic & Government Influences* 9.1.12.EG.6: Analyze the rights and responsibilities of buyers and sellers under consumer protection laws.

		Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner. 9.3.ST-SM.1 Apply science and mathematics to provide results, answers, and algorithms for engineering and technological activities. 9.3.ST-SM.2 Apply science and mathematics concepts to the development of plans, processes and projects that address real world problems. 9.3.ST-SM.3 Analyze the impact that science and mathematics has on society. *Computer Science & Design Thinking Computing Systems*			rebuild a small gas engine. Students will be able to describe four stroke cycle engine operations and explain the purpose of each stroke. Students will be able to discuss simple engine operation. Students will be able to discuss the four-stroke cycle. Students will be able to reinforce their knowledge of content by disassembling and reassembling small gas engine. Students will be able to define the following terms:	Quiz (es) Unit Test(s) Unit Project Successful completion of safety test and assignments	criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	

		8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. *Computer Science & Design Thinking Algorithms & Programming* 8.1.12. AP.3: Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice. 8.1.12. AP.4: Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue. 8.1.12. AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as			• Crankshaft • Camshaft • Valves • Timing marks • Cylinder • Combustion • Sparkplug • Flywheel • Keyways • Sump cover • Piston • Connecting rod • Carburetor • Head • Block • Cooling			

		procedures, modules, and/or objects. 8.1.12. AP.6: Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. 8.1.12. AP.7: Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users. 8.1.12. AP.8: Evaluate and refine computational artifacts to make them more usable and accessible. 8.1.12. AP.9: Collaboratively document and present design decisions in the development of complex programs.						

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WEBLIOGRAPHY

None.

ASSOCIATED JOBS LIST BY UNIT

Unit 1 – Energy	Energy Engineer Energy Advisor Energy Utility Network Operations Manager Electrical Engineers Energy & Sustainability Engineer Inspection Coordinator Regulatory Specialist High-Energy Physicist Electrician Power System Operations Specialist Nuclear Engineer
Unit 2- General Tools, Measurements and Material Processing	Machinist Wood Workers Engineers Contractors Construction Workers Material Scientists Processing Plant Operators
Unit 3- Mechanical Energy and Simple Machines	Mechanical Engineer, Construction Engineer, Construction Superintendent, Project Engineer, Construction Estimator, Construction Inspector, Journeyman Electrician, Plumber, Pipefitter, Carpenter, Equipment Operator, Construction Laborer
Unit 4 – Electricity	Electrician Energy Engineer Energy Advisor Energy Utility Network Operations Manager Electrical Engineers Energy & Sustainability Engineer Inspection Coordinator Regulatory Specialist High-Energy Physicist Electrician Power System Operations Specialist Nuclear Engineer
Unit 5- Energy Types	Solar Energy Engineer Wind Energy Engineer Hydropower Engineer Biomass Engineer Biofuel Engineer Biofuel Technician Geothermal Energy Engineer Solar Panel Installation Operator Construction Worker Energy Resource Analyst Chemical Engineer Environmental Technician
Unit 6– Transportation Technical Systems	Transportation Engineer, Drivers, Distribution Manager, Automotive Service Technician/Mechanic, Cargo & Freight Agent, Material Moving Machine Operator

Unit 7- Energy & Power Technologies on the Environment	Environmental Engineer Civil/Environmental Engineer Energy & Power Technologist Marine Biologist Molecular Biology Technician, Microbiology Quality Control Technician, Water Quality Technician
Unit 8 – Tools & General Safety in the Small Engines Shop	Manufacturing Engineer, Maintenance Engineer, Mechanic, Plant Operator, Shop Forman, Factory Worker, Woodworker, Stationary Engineer, Welder, Plumber, Mold Maker, Laboratory Technician, Lab Manager
Unit 9- Engine Construction and Principles of Operation	Mechanic Auto-CAD Engineer Plant Operator Manager Construction Engineer Civil Engineer Research Scientist Quality Control Technician