Unit 02: Electro-Mechanical Design

Content Area: **Template**
Course(s):
Time Period: **Full Year**
Length: **FY**
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Standards Alignment

New Jersey Student Learning Standards

Practice 1. Asking questions (for science) and defining problems (for engineering)
Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.

Ask questions to determine relationships between independent and dependent variables and relationships in models.

Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.

Ask questions that require sufficient and appropriate empirical evidence to answer.

Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Ask questions that challenge the premise(s) of an argument or the interpretation of a data set.

Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

Practice 2. Developing and using models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Evaluate limitations of a model for a proposed object or tool.

Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed.

Use and/or develop a model of simple systems with uncertain and less predictable factors.

Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.

Develop and/or use a model to predict and/or describe phenomena.

Develop a model to describe unobservable mechanisms.

Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.

Practice 5. Using mathematics and computational thinking
Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

Create algorithms (a series of ordered steps) to solve a problem.

Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.

Use digital tools and/or mathematical concepts and arguments to test and compare proposed solutions to an engineering design problem.

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Construct an explanation using models or representations.

Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.

Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.

Practice 8. Obtaining, evaluating, and communicating information
Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.

Connections to Engineering, Technology and Applications of Science
Interdependence of Science, Engineering, and Technology

Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.

Science and technology drive each other forward.

Influence of Engineering, Technology, and Science and the Natural World

The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Technology use varies over time and from region to region.

Connections to the Nature of Science: Most Closely Associated with Crosscutting Concepts
Science is a Way of Knowing

Science knowledge is cumulative and many people, from many generations and nations, have contributed to science knowledge.

Science is a way of knowing used by many people, not just scientists.

Integration of Career Readiness, Life Literacies and Key Skills

CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP3	Attend to personal health and financial well-being.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP5	Consider the environmental, social and economic impacts of decisions.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP9	Model integrity, ethical leadership and effective management.
CRP.K-12.CRP10	Plan education and career paths aligned to personal goals.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.

Technology / Integration of Computer Science and Design Thinking

TECH.8.1.8	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.8.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.8.A.1	Demonstrate knowledge of a real world problem using digital tools.
TECH.8.1.8.A.3	Use and/or develop a simulation that provides an environment to solve a real world problem or theory.
TECH.8.1.8.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
TECH.8.1.8.E.1	Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem.
TECH.8.2.8	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.8.A	The Nature of Technology: Creativity and Innovation: Technology systems impact every aspect of the world in which we live.
TECH.8.2.8.A.2	Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system.
TECH.8.2.8.A.5	Describe how resources such as material, energy, information, time, tools, people, and capital contribute to a technological product or system.
TECH.8.2.8.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.8.C.1	Explain how different teams/groups can contribute to the overall design of a product.
TECH.8.2.8.C.2	Explain the need for optimization in a design process.
TECH.8.2.8.C.3	Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
TECH.8.2.8.C.8	Develop a proposal for a chosen solution that include models (physical, graphical or mathematical) to communicate the solution to peers.

TECH.8.2.8.C.5b	Create a technical sketch of a product with materials and measurements labeled.
TECH.8.2.8.D	Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
TECH.8.2.8.D.1	Design and create a product that addresses a real world problem using a design process under specific constraints.
TECH.8.2.8.D.3	Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.
TECH.8.2.8.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.
TECH.8.2.8.E.2	Demonstrate an understanding of the relationship between hardware and software.
TECH.8.2.8.E.3	Develop an algorithm to solve an assigned problem using a specified set of commands and use peer review to critique the solution.
TECH.8.2.8.E.4	Use appropriate terms in conversation (e.g., programming, language, data, RAM, ROM, Boolean logic terms).

Interdisciplinary Connections: NJSLS for ELA, Social Studies, Science and/or Math Section

	Key Ideas and Details
LA.K-12.NJSLSA.R1	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
LA.K-12.NJSLSA.R3	Analyze how and why individuals, events, and ideas develop and interact over the course of a text.
LA.K-12.NJSLSA.R8	Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
LA.K-12.NJSLSA.R9	Analyze and reflect on how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.
	Range of Reading and Level of Text Complexity
LA.K-12.NJSLSA.R10	Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed.
LA.RI.8	Reading Informational Text
LA.RI.8.1	Cite the textual evidence and make relevant connections that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
LA.K-12.NJSLSA.W	Writing
LA.RI.8.3	Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).
LA.K-12.NJSLSA.W2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
LA.RI.8.8	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
LA.RI.8.9	Analyze and reflect on (e.g., practical knowledge, historical/cultural context, and background knowledge) two or more texts that provide conflicting information on the

	same topic and identify where the texts disagree on matters of fact or interpretation.
	Research to Build and Present Knowledge
LA.K-12.NJSLSA.W7	Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
LA.K-12.NJSLSA.W8	Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
LA.RI.8.10	By the end of the year read and comprehend literary nonfiction at grade level text-complexity or above, with scaffolding as needed.
LA.K-12.NJSLSA.W9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
LA.W.8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
LA.W.8.2.A	Introduce a topic and organize ideas, concepts, and information, using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia).
LA.W.8.2.B	Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
LA.W.8.2.C	Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
LA.W.8.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.
LA.W.8.2.E	Establish and maintain a formal style/academic style, approach, and form.
LA.W.8.2.F	Provide a concluding statement or section that follows from and supports the information or explanation presented.
LA.W.8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
LA.W.8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
LA.W.8.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
LA.W.8.9.B	Apply grade 8 Reading standards to literary nonfiction (e.g., “Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced”).

Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media LiteracyNew Section

see Crosswalks

21st Century Life and Careers

Stage I: Desired Results

Transfer/Overview/Rationale

Transfer / Overview / Rationale

Unit Rationale

The purpose of this unit…

Simple and Compound Machines, Circuits, Motors, Servos, and Gearing

In this unit, students will learn about and gain experience using simple and compounds machines to better leverage the power of robotic components. To gain more power or speed from rotational forces, students will be introduced to the concept of gearing. Students will also learn the basics of DC circuitry and how electricity works to power components. This knowledge will be immediately put to use in the powering of DC motors and servos. Using these components with simple and compound machines will allow machines and robots built in the course to perform their programmed actions.

Meaning

Essential Questions

Essential Questions

What are the six simple machines and how do they allow work to be done easier?

What are the essential components in an electrical circuit?

How do motors and servos differ and how are they similar?

Why might a servo be chosen for a project over a motor?

How do gears manipulate rotational force?

Enduring Understanding/Indicators of Understanding

Enduring Understanding/Indicators of Understanding

There are six simple machines that, when used alone or combined, allow work to be done easier.

For electricity to power a device or component, its circuit must be a closed loop.

Motors and servos are two different electro-mechanical ways to impart rotational force to a machine.

Using gears allows for a known rotational force to be manipulated without changing the initial force.

Acquisition (Student Learning Objectives)

Knowledge

Knowledge

Students will know…

The six simple machines are the lever, wheel and axle, inclined plane, wedge, pulley, and screw.

The essential components of an electrical circuit are a power source, conductors, load, controls/switches, and ground.

Motors are simply powered, and spin at a constant speed given set voltages and currents.

Servos are powered but need to be controlled to track their position.

Gears can be used to increase or decrease rotational speed, heighten or lower rotational torque, transfer radial motion from one axis to another, and into linear motion.

Skills

Skills

Student will be skilled at …

Identifying each of the six simple machines in both simple and compound forms.

Constructing complete circuits using essential components.

Powering and controlling motors and servos from an Arduino.

Constructing simple and compound gear ratios to change rotational force.

Identifying gear types.

Incorporating simple and compound machines, circuits, motors, servos, and gearing into their machine designs.

Stage 3: Learning Plan

Resource and Mentor Texts

Resources and Mentor Texts

“Curricular Unit: Simple Machines” - https://www.teachengineering.org/curricularunits/view/cub_simp_machines_curricularunit

“Simple Machines: Facts” - http://idahoptv.org/sciencetrek/topics/simple_machines/facts.cfm

“Building Stonehenge - This Man can Move Anything” (video) - https://www.youtube.com/watch?v=lRRDzFROMx0

“ReadySetSTEM Curriculum” (circuits/breadboards) - http://www.readysetstem.com/projectsguide_full/

***Make: Electronics*, by Charles Platt**

“How to Use a Breadboard” - https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard

“Stepper vs. Servo” - https://www.amci.com/industrial-automation-resources/plc-automation-tutorials/stepper-vs-servo/

***Electric Motors and Drives*, by Austin Hughes**

“Gears” - https://www.engineering.com/Library/ArticlesPage/tabid/85/ArticleID/131/categoryId/11/Gears.aspx

“Engineering Mechanisms: Gears” - https://www.creativemechanisms.com/gears

“Gear Generator” (this is really cool) - https://geargenerator.com/

***Dudley’s Handbook of Practical Gear Design and Manufacture* by Stephen P. Radzevich.**

“Five Hundred and Seven Mechanical Movements” - http://507movements.com/

“Arduino-Based Robotics” - http://steamcurriculum.weebly.com/arduino-based-robotics.html

Formative Assessment Strategies

Formative Assessment Strategies

Teacher observation

Class discussion

Arduino example activities

Simple Machine activities

Motors and servos discussion and activities

Gearing practice

Google Classroom Questions

Learning Activities/Unit of Study

Learning Activities/Unit of Study

Google Classroom Daily Questions

Discussion of simple and compound machines

Overview of electricity and circuits

Building circuits on a breadboard discussion/activity

Differences and similarities between motors and servos

Wiring motors and servos into circuits/Arduino

Gearing discussion and activities

Modifications and/or Accommodations

Suggested Modifications (ELL, Sp. Ed, GIfted, At-risk of Failure)

English Language Learners

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing the students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

Special Education Students

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily

overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

Students with 504 Plans

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Gifted & Talented Strategies

Extensions/Enrichments: Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

Modify/Change Activities: Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

Students at Risk of School Failure

Directions or Instructions: Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

Peer Support: Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for clarification before going to you.

Alternate or Modified Assignments: Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

Increase One to One Time: When other students are working, always touch base with your students at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

Contracts: It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

Hands On: As much as possible, think in concrete terms and provide hands-on tasks. This means a child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.