Engineering III

Unit Title: Fabrication and Design

Stage 1: Desired Results

Standards & Indicators:

NJSLS for Computer Science and Design Thinking
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 modifications to 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.

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).

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

8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment

CTE Standards
9.3.12.AC.6 Read, interpret and use technical drawings, documents and specifications to plan a project.

9.3.12.AC-DES.6 Apply the techniques and skills of modern drafting, design, engineering and construction to projects.

9.3.12.AC-DES.1 Justify design solutions through the use of research documentation and analysis of data.

9.3.12.AC-DES.2 Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues

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.

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9.3.12.AC-CST.7 Compare and contrast the building systems and components required for a construction project.

9.3.12.AC-CST.8 Demonstrate the construction crafts required for each phase of a construction project.

9.3.12.AC-CST.9 Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.

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.

Computer Science and Design Thinking		
Standard	**Performance Expectations**	**Core Ideas**
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.	Engineering design is a complex process in which creativity, content knowledge, research, and analysis are used to address local and global problems. Decisions on trade-offs involve systematic comparisons of all costs and benefits, and final steps that may involve redesigning for optimization.
8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make modifications to 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.	
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).	Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.
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).	
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.	Changes caused by the introduction and use of a new technology can range from gradual to rapid and from subtle to obvious, and can change over time. These changes may vary from society to society as a result of differences in a society's economy, politics, and culture.
8.2.12.NT.1	Explain how different groups can contribute to the overall design of a product	Engineers use science, mathematics, and other disciplines to improve technology. Increased collaboration among engineers, scientists, and mathematicians can improve their work and designs. Technology,

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		product, or system redesign can be more difficult than the original design.
8.2.12.ETW.2	Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment	Development and modification of any technological system needs to take into account 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. Many technologies have been designed to have a positive impact on the environment and to monitor environmental change over time
Career Readiness, Life Literacies and Key Skills		
Standard	**Performance Expectations**	**Core Ideas**
9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).	With a growth mindset, failure is an important part of success.
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).	Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.
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 projects and determine the strategies that contribute to effective outcomes.	
9.4.12.TL.1	Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task (e.g., W.11-12.6.).	Digital tools differ in features, capacities, and styles. Knowledge of different digital tools is helpful in selecting the best tool for a given task.
9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	
9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.	Collaborative digital tools can be used to access, record and share different viewpoints and to collect and tabulate the views of groups of people.
9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).	

Central Idea/Enduring Understanding:	**Essential/Guiding Question:**
Accuracy and attention to detail while using tools leads to efficient fabrication.	• What does it mean to use tools efficiently? • How can inaccurate measuring affect a project? • How is attention to detail related to accuracy?

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Selecting the right tools and materials are necessary to be a successful engineer. Innovation is as important as invention.	• What are the effects of tool and material selection? • How can availability of tools and materials affect product design? • What can you learn from someone else's design? • How are analysis and innovation related? • Why should we constantly evaluate the product?
Content: • Safety rules for fabrication tools. • Properties and limitations of tools and materials. • Evaluation of invention and innovation.	**Skills(Objectives):** Use fabrication tools safely. Measure materials accurately so that they are used as efficiently and economically as possible. Fabricate project components from 2D and 3D CAD designs and models. Problem-solve fabrication issues. Select appropriate materials. Design products according to the tools available. Research different models/generations of an existing product and evaluate the success of newer innovations. Evaluate an innovation and propose additional innovations. Develop and manage a project plan using project management software. Design and implement electronic circuits using a microcontroller (Audrino)
Interdisciplinary Connections: As students learn concepts, they will develop projects that demonstrate their proficiency in science, math, literacy, and computer science.	

Stage 2: Assessment Evidence

Performance Task(s): Students will be able to independently use their learning to fabricate a product according to varied design specifications.	**Other Evidence:** Engineering Logbooks Project Rubrics Quizzes RoadMap and Mock up of project Peer Review Tests Self-Assessment by student of their learning activities Teacher observation of student performance during learning activities

Stage 3: Learning Plan

Learning Opportunities/Strategies: Individual and group presentations Demonstrations Programming	**Resources:** Audrino TinkerCad Videos 3D Printers

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Design Presentations Small group work Guest Speakers	Glowforge Google Apps for Education LGBT and Disabilities Resources: ● LGBTQ-Inclusive Lesson & Resources by Garden State Equality and Make it Better for Youth ● LGBTQ+ Books DEI Resources: ● Learning for Justice ● GLSEN Educator Resources ● Supporting LGBTQIA Youth Resource List ● Respect Ability: Fighting Stigmas, Advancing Opportunities ● NJDOE Diversity, Equity & Inclusion Educational Resources ● Diversity Calendar

Differentiation *Please note: Teachers who have students with 504 plans that require curricular accommodations are to refer to Struggling and/or Special Needs Section for differentiation

High-Achieving Students	On Grade Level Students	Struggling Students	Special Needs/ELL
On Grade level activities plus additional projects and leadership roles on project teams. Mentoring other students	Projects Engineering Logbooks Presentations Project Meeting minutes	On Grade level activities plus projects based on the student's ability. Extra time One on One coaching opportunities during study hall and after school tutoring Work with a student mentor.	Any student requiring further accommodations and/or modifications will have them individually listed in their 504 Plan or IEP. These might include, but are not limited to: breaking assignments into smaller tasks, giving directions through several channels (auditory, visual, kinesthetic, model), and/or small group instruction for reading/writing ELL supports should include, but are not limited to, the following:: Extended time Provide visual aids Repeated directions Differentiate based on proficiency Provide word banks Allow for translators, dictionaries

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Pacing Guide

Engineering II	Content/Resources	Standards
UNIT 1:		
Creativity and Design Process (90 Days)	Audrino TinkerCad Videos GlowForge 3D Printers Google Apps for Education	8.2.12.ED.1-6 8.2.12.ITH.2 8.2.12.NT.1 8.2.12.ETW.2 9.3.ST-ET.1-4 9.3.ST-SM.1-2 9.3.12.AC.6 9.3.12.AC-DES.6 9.3.12.AC-DES.1 9.3.12.AC-DES.2 9.3.12.AC-CST.7 9.3.12.AC-CST.8 9.3.12.AC-CST.9