Boonton School District

Course Title:	Introduction to Engineering Honors / Dual Credit (0893)	**Grade Level(s):**	**11-12**		
Curriculum Area / Level:	Technology (11-12)	**Credits:**	**5**		
Course prerequisites and/or co-requisites:	Technology department course; teacher recommendation; strong background in physics and algebra or higher				
Course Description:	This college level course introduces students to the practice of engineering design. Students will use hand tools, reverse engineering, the creative process, and learn about the various career paths within engineering. This course is intended for any student interested in understanding the basics of engineering design and learning about engineering as a possible career. Textbook: Engineering Design: An Introduction, 2nd Edition Karsnitz, J., O'Brien, S., & Hutchinson, J. © 2013 Delmar, Cengage Learning ISBN-13: 978-1111645825 Student Workbook ISBN-13: 978-1111645847				
Created by:	Vicki L. Cornell	**Date:**	August 2016	**BOE Approval:**	9/26/16
District Equity Statement:	As required by state law, it is the policy of Boonton School District not to discriminate on the basis of race, color, creed, religion, sex, ancestry, national origin, social or economic status, pregnancy, or physical handicap in its educational programs or activities and to maintain a learning environment that is free from sexual harassment. Courses of study and instructional materials shall be designed and selected in order to eliminate discrimination and promote understanding, sex equity, and mutual respect among people. No course offering, including but not limited to physical education, health, technology education, vocational, home economics, music and adult education, shall be limited on the basis of race, color, creed, religion, sex, ancestry, national origin, social or economic status, pregnancy, or physical handicap. Furthermore, there shall be no discrimination against students as to any educational activity or program because of pregnancy, childbirth, pregnancy-related disabilities, actual or potential parenthood, or family or marital status. If a student requests to be excluded or a physician certifies that such is necessary for her physical, mental, or emotional well-being, she must be provided with adequate and timely opportunity for instruction to continue or make up her schoolwork without prejudice or penalty.				

Division of Umbrella & Mini Units	
Umbrella Unit 1 Topic / Name: **Principles of Engineering Design**	**Mini Units** **1A. The Engineered World** **1B. Engineering Tools & Safety** **1C. Think Like an Engineer** **1D. Documenting the Design Process**
Umbrella Unit 2 Topic / Name: **Applied Engineering: Foundations**	**Mini Units** **2A. The Built World** **2B. Mechanical Design** **2C. Electrical Design**
Umbrella Unit 3 Topic / Name: **Applied Engineering: Integrated Systems**	**Mini Units** **3A. Design & Prototyping** **3B. Testing, Analysis & Redesign** **3C. Fluid Power**
Umbrella Unit 4 Topic / Name: **Human Factors in Design and Engineering**	**Mini Units** **4A. Ergonomics & Product Development** **4B. Bioengineering** **4C. Independent Project**

UMBRELLA UNIT 1	
Title:	Principles of Engineering Design
Duration:	9 weeks
Essential Questions:	What is engineering and what do engineers do? How has engineering shaped society? How do engineers solve problems using the Engineering Design Process? How do the systems model and systems thinking apply to the Engineering Design Process? How do Engineers convey their design ideas? Why do Engineers maintain logbooks or journals? How does one participate as a design team member? Why is investigation and research necessary? How do I decide what questions to ask? What types of research might I need to do? How do I conduct the research I need to answer questions about my design problem? Why is freehand sketching an important skill for a designer, scientist, or engineer? Why do engineers and other designers need to document their work? How do engineers, designers, and consumers use technical drawings? What standards are used to draw and dimension orthographic multiview drawings, and who sets these standards? How do technical drawings fit in with the engineering design process? What are the characteristics of CAD modeling programs that make them such a powerful tool?
Summative Assessments: **(Assessment at the end the learning period)**	Summative Assessment #1: Critical thinking Questions & Project-Based component Online Portfolio Creation & Review Personalized Student Learning Plan assessment - Unit 1
Formative Assessments: **(Ongoing assessments**	Engineering Tools & Materials: Classroom Safety Quiz Chapter / unit quiz Exit tickets

during the learning period)	Do Now exercises Student self-assessments / reflections Personalized Student Learning Plan goal monitoring
Differentiation:	Varied delivery formats: lecture, video, self-guided research, group discussion, think-pair-share Graphic organizers & infographics Enhancing existing portfolio Independent research Journal reflection Design critiques Group presentation or graphic display (i.e., poster, alternative media) Student choice / student goal planning and management Metacognitive strategies based on student's interests and background knowledge Design circles / flexible grouping Exit tickets as formative assessment Tiered tests
TECHNOLOGY STANDARD (STANDARD 8)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
8.2.12.A.1	Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.
8.2.12.A.2	Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability, and waste.
8.2.12.A.3	Research and present information on an existing technological product that has been repurposed for a different function.
8.2.12.B.1	Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.
8.2.12.B.2	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.B.4	Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.
8.2.12.B.5	Research the 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 to peers for review.
8.2.12.C.1	Brainstorm ideas on how to solve a problem or build a product.
8.2.12.C.2	Create a drawing of a product or device that communicates its function to peers and discuss.
8.2.12.C.3	Explain why we need to make new products.
8.2.12.C.4	Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models.
8.2.12.C.5	Explain the function of a system and subsystems.
8.2.12.D.1	Design a create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
8.2.12.D.3	Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.
21ST CENTURY LIFE AND CAREER (STANDARD 9)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
9.3.ST.1	Apply engineering skills in a project that requires project management, process control, and quality assurance.
9.3.ST.2	Use technology to acquire, manipulate, analyze and report data.
9.3.ST.3	Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.
9.3.ST.4	Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.

9.3.ST.5	Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.
9.3.ST.6	Demonstrate the technical skills needed in a chosen STEM field.
9.3.ST-ET.1	Use STEM concepts and processes to solve problems involving design and/or production.
9.3.ST-ET.2	Display and communicate STEM information.
9.3.ST-ET.3	Apply processes and concepts for the use of technological tools in STEM.
9.3.ST-ET.4	Apply the elements of the design process.
9.3.ST-ET.5	Apply the knowledge learned in STEM to solve problems.
9.3.ST-ET.6	Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.
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.
9.3.ST-SM.4	Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret, and summarize research and statistical data.
9.4.12.O.1	Demonstrate language arts knowledge and skills required to pursue the full range of postsecondary education and career opportunities.
9.4.12.O.2	Demonstrate mathematics knowledge and skills required to pursue the full range of postsecondary education and career opportunities.
9.4.12.O.3	Demonstrate science knowledge and skills required to pursue the full range of postsecondary education and career opportunities.
9.4.12.O.4	Select and employ appropriate reading and communication strategies to learn and use technical concepts and vocabulary in practice.

9.4.12.O.9	Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.
9.4.12.O.10	Interpret verbal and nonverbal cues/behaviors to enhance communication.
9.4.12.O.11	Apply active listening skills to obtain and clarify information.
9.4.12.O.13	Listen to and speak with diverse individuals to enhance communication skills.
9.4.12.O.15	Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.
9.4.12.O.16	Apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.
9.4.12.O.17	Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.
9.4.12.O.19	Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.
9.4.12.O.22	Employ technological tools to expedite workflow.
9.4.12.O.24	Operate Internet applications to perform tasks.
9.4.12.O.29	Employ collaborative / groupware applications to facilitate group work.
9.4.12.O.32	Effectively use information technology to gather, store, and communicate data in appropriate formats.
9.4.12.O.33	Evaluate and demonstrate skill with a range of technological tools designed to manipulate, report, or operate with data acquisition.
9.4.12.O.38	Demonstrate knowledge of personal and jobsite safety rules and regulations to maintain safe and healthful working conditions and environments.
9.4.12.O.39	Demonstrate knowledge of employee rights and responsibilities and employers' obligations to maintain workplace safety and health.
9.4.12.O.40	Identify emergency procedures that are necessary to provide aid in workplace accidents.

9.4.12.O.42	Explain health, safety, and environmental management systems in organizations and their importance to organizational performance and regulatory compliance.
9.4.12.O.44	Apply appropriate safety practices in environments in this cluster to ensure a safe workplace.
9.4.12.O.45	Develop an awareness of safety, health, and environmental hazards inherent in this cluster and apply appropriate precautions when solving problems, developing plans, implementing processes, or completing projects to proactively promote safety.
9.4.12.O.46	Employ leadership skills to accomplish goals and objectives.
9.4.12.O.47	Employ organizational skills to foster positive working relationships and accomplish organizational goals.
9.4.12.O.48	Employ teamwork skills to achieve collective goals and use team members' talents effectively.
9.4.12.O.49	Establish and maintain effective relationships in order to accomplish objectives and tasks.
9.4.12.O.55	Identify and demonstrate positive work behaviors and personal qualities needed to succeed in the classroom and/or to be employable.
9.4.12.O.56	Develop a Personalized Student Learning Plan to meet career goals and objectives.
9.4.12.O.58	Maintain a career portfolio to document knowledge, skills, and experience in a career field.
9.4.12.O.(1).2	Apply and use algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve problems.
9.4.12.O.(1).3	Demonstrate the ability to select, apply, and convert systems of measurement to solve problems.
9.4.12.O.(1).8	Select and use a range of communications technologies, including word processing, spreadsheet, database, presentation, email, and Internet applications, to locate and display information.
9.4.12.O.(1).12	Model technical competence by developing and applying processes and concepts in the design process.
9.4.12.O.(2).1	Develop an understanding of how science and mathematics function to provide results, answers, and algorithms for engineering activities to solve problems and issues in the real world.
9.4.12.O.(2).2	Apply science and mathematics when developing plans, processes, and projects to find solutions to real world

	problems.
9.4.12.O.(2).3	Assess the impact that science and mathematics have on society when used to develop projects or products.
NEXT GENERATION SCIENCE STANDARDS (HS-ETS1 ENGINEERING DESIGN)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
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, 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.

MINI UNIT 1A		
Title:	**The Engineered World**	
Duration:	**1 week**	
Overview:	**Students will develop an understanding that engineering design is a formal process that transforms ideas into products or systems of the designed world. Students will explore the story of engineering by studying the great engineering achievements of the twentieth century.**	
Essential Outcomes - Upon completion of this course students will know (declarative):		**Alignment to Standards**

Engineers apply math, science, and aesthetic principles to create successful designs.	9.3.ST.1, 9.3.ST-ET.4
Engineers use knowledge of physical principles to design products, systems or environments.	9.3.ST.1
Current and future global demand for skilled engineers and related professions continues to climb as technological advancements impact our society.	9.3.ST.5
Engineering's code of ethics	9.3.ST-ET.6
Technology in a given period of history (e.g., industrial revolution or information age) impacts and changes human needs and wants.	8.2.12.B.4
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Analyze the global impact that engineering has on society	9.3.ST-SM.3
Describe the development of engineering advancements over the centuries	9.3.ST-SM.3
Summarize notable engineering achievements of the 20th century (water supply & distribution, electricity, automobile, aircraft, electronics, radio, television, mechanization, computers, HVAC, etc)	9.3.ST.4
Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability, and waste.	8.2.12.A.2
Research and present information on an existing technological product that has been repurposed for a different function.	8.2.12.A.3
Develop a student portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Why we need to make new products.	8.2.12.C.3

Technology is a product or system that results from design.	9.3.ST-ET.1
New understanding and knowledge is gained through design and production.	9.3.ST.4, 9.3.ST-SM.3
The product life cycle and how it affects design	9.3.ST.1
How the Industrial Revolution transformed the way people lived and worked.	9.3.ST.4

Resources Mini Unit 1A:	Textbook Chapter 1 Engineering Fundamentals (ISBN 978-1-61960-220-5): Chapter 1 http://www.g-wlearning.com/technologyeducation/ Selected video clips and news articles https://www.uspto.gov/ Google Classroom environment Google Drive online portfolio Scissors, Tape, Glue, Fasteners, Various scrap materials

MINI UNIT 1B	
Title:	**Engineering Tools & Safety**
Duration:	**2 weeks**
Overview:	**Before engaging in projects throughout the course, students will be exposed to and learn to employ safe operating practices during various structured design projects. Students must pass a safety exam prior to starting the next unit, and will receive training from the OSHA / NIOSH Youth @ Work Safety Program.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
Safety, health and environmental standards related to engineering workplaces.	9.3.ST.3

How to safely operate all tools and equipment used in the course.	9.4.12.O.44, 9.4.12.O.45
Emergency procedures that are necessary to provide aid in workplace accidents.	9.4.12.O.40
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Describe and follow safety procedures in the classroom engineering environment	9.3.ST.3
Demonstrate safe use of tools and equipment related to engineering design	9.3.ST.6
Demonstrate knowledge of of personal and jobsite safety rules and regulations to maintain safe and healthful working condition and environments.	9.4.12.O.38
Develop an awareness of safety, health, and environmental hazards inherent in this cluster and apply appropriate precautions when solving problems, developing plans, implementing processes, or completing projects to proactively promote safety.	9.4.12.O.45
Demonstrate positive work behaviors and personal qualities needed to succeed in the classroom and / or be employable.	9.4.12.O.55
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
The safe use of tools and machines allows engineers to successfully complete their designs.	9.3.ST.1
Following specific safety rules is essential to work in a design and production environment.	9.4.12.O.42
Employees have rights and responsibilities, and employers have obligations to maintain workplace safety and health.	9.4.12.O.39
Resources Mini Unit 1B:	Classroom tools and materials SDS sheets Safety Goggles Cutting mats Google Classroom Environment

	Google Drive Portfolio http://www.cdc.gov/niosh/talkingsafety/states/nj/2015-148/pdfs/Talking_Safety_NJ.pdf https://www.osha.gov/youngworkers/parents-educators.html

MINI UNIT 1C	
Title:	**Think Like an Engineer**
Duration:	**5 weeks**
Overview:	**Students will examine and apply each step of the Engineering Design Process to solve problems. Students will learn to identify problems and opportunities, how to organize a design team, how to utilize systems thinking, how to conduct research and document information about a problem. Students will work individually and in teams to solve design problems. Each student will develop a personalized student learning plan to meet their goals and objectives.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
Engineering design is a process used to help develop solutions to problems purposefully, and in a controlled and logical sequence.	9.3.ST-ET.4
Failure is an important part of the design process.	8.2.12.C.1
Technology is used to access, manage, integrate and disseminate information.	9.3.ST.2, 9.4.12.O.22, 9.4.12.O.24, 9.4.12.O.29, 9.4.12.O.32, 9.4.12.O.33
Designs are created within constraints. Constraints are driven by cultural, social, economic and political needs.	8.2.12.B.1
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Interpret and apply the steps of the Engineering Design Process.	9.3.ST-ET.4, HS-ETS1-1

Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models.	8.2.12.C.4
Research the 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 to peers for review.	8.2.12.B.5
Utilize the Engineering Design Process to solve an engineering problem.	9.3.ST-ET.4, HS-ETS1-3
Document and convey the steps used in the Engineering Design Process.	9.3.ST-ET.4
Differentiate the work involved in each step of the Engineering Design Process.	HS-ETS1-2
Write a sample design brief.	9.3.ST.1, 9.3.ST-SM.2, 9.3.ST-SM.4
Utilize effective communication skills when working in a team setting.	9.4.12.O.10, 9.4.12.O.11, 9.4.12.O.13
Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
Demonstrate the language arts, mathematics, and science knowledge required to pursue the full range of postsecondary education and career opportunities.	9.4.12.O.1, 9.4.12.O.2, 9.4.12.O.3
Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.	9.4.12.O.9
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19
Employ leadership skills to accomplish goals and objectives.	9.4.12.O.46
Employ organizational skills to foster positive working relationships and accomplish organizational goals.	9.4.12.O.47
Employ teamwork skills to achieve collective goals and use team members' talents effectively.	9.4.12.O.48

Establish and maintain effective relationships in order to accomplish tasks.	9.4.12.O.49
Develop a personalized student learning plan to meet career goals and objectives.	9.4.12.O.56
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Select and use a range of communication technologies, including word processing, spreadsheet, database, presentation, email and internet applications, to locate and display information.	9.4.12.O.(1).8
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
That the Engineering Design Process is a logical framework for problem-solving.	9.3.ST.4
Design goals should achieve desired effects and minimize undesired effects (control risk).	8.2.12.A.1
Engineers practice various “versions” of the Engineering Design Process. However, each follows a general standard of systematic and logical problem-solving to achieve a successful solution.	9.3.ST-ET.5
The function of a system and subsystems	8.2.12.C.5
Engineers 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.B.2
Engineers employ critical thinking skills (e.g., analyze, synthesize, evaluate) independently and in teams to solve problems and make decisions.	9.4.12.O.17
How science and mathematics function to provide results, answers, and algorithms for engineering activities to solve problems and issues in the real world.	9.4.12.O.(2).1
The impact science and mathematics have on society when used to develop projects or products.	9.4.12.O.(2).3

Resources Mini Unit 1C:	Textbook Chapter 2 Textbook Chapter 3 Textbook Chapter 4 Textbook Chapter 7 Straws, pins, tape, clothes pins, foam core board, balloons, rubber bands, fishing line, cardstock, dowels, hot glue guns, glue, scissors, paper clips, jar lids, other available miscellaneous materials Google Classroom Environment Google Drive Portfolio

MINI UNIT 1D	
Title:	**Documenting the Design Process**
Duration:	**1 week**
Overview:	**Students will learn how to use sketching and technical drawings to develop and communicate design ideas and how to work toward and produce an innovative solution. Students will explore both traditional (drawing and sketching) and current technological methods (CAD) of graphically conveying their ideas.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
How to determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system	8.2.12.D.3
Engineers use computer simulations to model the impact of a proposed solution to a complex real-world problem with numerous criteria and constraints.	HS-ETS1-4
How to select and employ appropriate reading and communication strategies to learn and use technical concepts and vocabulary in practice.	9.4.12.O.4
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**

Create a drawing of a product or device that communicates its function to peers, and discuss	8.2.12.C.2
Display and communicate STEM information	9.3.ST-ET.2
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Apply and use algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve problems.	9.4.12.O.(1).2
Demonstrate the ability to select, apply, and convert systems of measurement to solve problems.	9.4.12.O.(1).3
Model technical competence by developing and applying processes and concepts in the design process.	9.4.12.O.(1).12
Apply science and mathematics when developing plans, processes, and projects to find solutions to real world problems.	9.4.12.O.(2).2
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Active listening skills are essential for obtaining and clarifying information pertaining to plans, processes, projects, and designs.	9.4.12.O.16
Engineers prepare science, technology, engineering, and mathematical material in oral, written, and visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.	9.4.12.O.15
How to apply processes and concepts for the use of technological tools in STEM.	9.3.ST-ET.3
Resources Mini Unit 1D:	Textbook Chapter 5 Textbook Chapter 8 Textbook Chapter 16 Textbook Chapter 18 Paper, Graph paper, pencils, erasers, rulers, scales, triangles, poster or tracing paper for sketching Autodesk Inventor

	Google SketchUp Google Classroom Environment Google Drive Portfolio

UMBRELLA UNIT 2	
Title:	Applied Engineering: Foundations
Duration:	11 weeks
Essential Questions:	How do engineers apply specific skill sets and competencies needed for the Engineering Design Process? Why is the visual appearance or style of an object an important part of the design process? How can different styles be identified and classified? What are structures and how are they different than other human-designed things? Why do structures fail? What must be understood to design a structure? How do loads and natural forces affect structures? What types of components are used to design and build structures? How do you calculate loads on structures? Why do mechanical engineers and other design professionals design and build mechanisms? What STEM principles must be understood to design a mechanism? How are desired output motions created with mechanisms? How are levers and linkages used in design mechanisms? How can mechanical designs be modeled? What is electricity? How do simple electrical circuits work? How has the semiconductor revolutionized human society?
Summative Assessments: **(Assessment at**	Summative Assessment #2: critical thinking questions & project-based component Online Portfolio Review

the end the learning period)	Personalized Student Learning Plan assessment - Unit 2
Formative Assessments: **(Ongoing assessments during the learning period)**	Chapter / unit quizzes Circuit design, building, testing, and troubleshooting Exit tickets Do Now exercises Student self-assessments / reflections Personalized Student Learning Plan goal monitoring
Differentiation:	Varied delivery formats: lecture, video, self-guided research, group discussion, think-pair-share Graphic organizers & infographics Enhancing existing portfolio Independent research Journal reflection Design critiques Group presentation or graphic display (i.e., poster, alternative media) Student choice / student goal planning and management Metacognitive strategies based on student's interests and background knowledge Design circles / flexible grouping Exit tickets as formative assessment Tiered tests
TECHNOLOGY STANDARD (STANDARD 8)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
8.2.12.A.1	Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.
8.2.12.A.2	Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability, and waste.
8.2.12.A.3	Research and present information on an existing technological product that has been repurposed for a different function.

8.2.12.B.2	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.B.4	Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.
8.2.12.B.5	Research the 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 to peers for review.
8.2.12.C.1	Brainstorm ideas on how to solve a problem or build a product.
8.2.12.C.2	Create a drawing of a product or device that communicates its function to peers and discuss.
8.2.12.C.4	Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models.
8.2.12.C.5	Explain the function of a system and subsystems.
8.2.12.C.6	Examine a malfunctioning tool and identify the process to troubleshoot and present options to repair the tool.
8.2.12.C.7	Work with peers to redesign an existing product for a different purpose.
8.2.12.D.1	Design a create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
8.2.12.D.3	Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.
8.2.12.D.4	Assess the impacts of emerging technologies on developing countries.
8.2.12.D.5	Explain how material processing impacts the quality of engineered and fabricated products.
8.2.12.D.6	Synthesize data, analyze trends and draw conclusions regarding the effect of a technology on the individual, society, or the environment and publish conclusions.
21ST CENTURY LIFE AND CAREER (STANDARD 9)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**

9.3.ST.1	Apply engineering skills in a project that requires project management, process control, and quality assurance.
9.3.ST.5	Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.
9.3.ST.6	Demonstrate the technical skills needed in a chosen STEM field.
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-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.
9.4.12.O.5	Demonstrate use of the concepts, strategies, and systems for obtaining and conveying ideas and information to enhance communication.
9.4.12.O.6	Locate, organize, and reference written information from various sources to communicate with others.
9.4.12.O.8	Use correct grammar, punctuation, and terminology to write and edit documents.
9.4.12.O.9	Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.
9.4.12.O.12	Develop and interpret tables, charts, and figures to support written and oral communications.
9.4.12.O.13	Listen to and speak with diverse individuals to enhance communication skills.
9.4.12.O.14	Exhibit public relations skills in order to increase internal and external customer satisfaction.
9.4.12.O.15	Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide

	information to an intended audience and to fulfill the specific needs of that audience.
9.4.12.O.16	Apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.
9.4.12.O.17	Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.
9.4.12.O.18	Employ critical thinking and interpersonal skills to resolve conflicts.
9.4.12.O.19	Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.
9.4.12.O.20	Conduct technical research to gather information necessary for decision-making.
9.4.12.O.22	Employ technological tools to expedite workflow.
9.4.12.O.24	Operate Internet applications to perform tasks.
9.4.12.O.26	Operate presentation applications to prepare and deliver presentations.
9.4.12.O.27	Employ spreadsheet applications to organize and manipulate data.
9.4.12.O.29	Employ collaborative / groupware applications to facilitate group work.
9.4.12.O.31	Use computer-based equipment containing embedded computers or processors to control devices.
9.4.12.O.50	Conduct and participate in meetings to accomplish tasks.
9.4.12.O.55	Identify and demonstrate positive work behaviors and personal qualities needed to succeed in the classroom and/or to be employable.
9.4.12.O.56	Develop a Personalized Student Learning Plan to meet career goals and objectives.
9.4.12.O.58	Maintain a career portfolio to document knowledge, skills, and experience in a career field.
9.4.12.O.68	Employ planning and time management skills and tools to enhance results and complete work tasks.
9.4.12.O.(1).1	Apply the concepts, processes, guiding principles, and standards of school mathematics to solve science, technology, engineering, and mathematics problems.

9.4.12.O.(1).3	Demonstrate the ability to select, apply, and convert systems of measurement to solve problems.
9.4.12.O.(1).4	Demonstrate the ability to use Newton's laws of motion to analyze static and dynamic systems with and without the presence of external forces.
9.4.12.O.(1).5	Explain relevant physical properties of materials used in engineering and technology.
9.4.12.O.(1).6	Explain relationships among specific scientific theories, principles, and laws that apply to technology and engineering.
9.4.12.O.(1).9	Employ concepts and processes for the application of technology to engineering.
9.4.12.O.(2).4	Use scientific and mathematical problem-solving skills and abilities to develop realistic solutions to assigned projects, and illustrate how science and mathematics impact problem-solving in modern society.
9.4.12.O.(2).6	Demonstrate the knowledge and technical skills needed to obtain and succeed in a chosen scientific and mathematical field.
NEXT GENERATION SCIENCE STANDARDS (HS-ETS1 ENGINEERING DESIGN)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
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, 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.

MINI UNIT 2A	
Title:	**The Built World**
Duration:	**4 weeks**
Overview:	**Students will explore architectural and construction history, techniques, and methods, before designing their own structure and testing its weight-bearing capacity.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
How to analyze a current technology in the built world and the resources used, to identify trade-offs in terms of availability, cost, desirability, and waste.	8.2.12.A.2
How to brainstorm ideas on how to solve a building / structures problem.	8.2.12.C.1
How to assess the impacts of emerging building & construction technologies on developing countries.	8.2.12.D.4
Material processing impacts the quality of engineered and fabricated products.	8.2.12.D.5
The technical skills needed in architecture & construction / infrastructure fields.	9.3.ST.6
Positive work behaviors and personal qualities are needed to succeed in the classroom and to be employable.	9.4.12.O.55
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Investigate the built world in a given period of history, and identify the impact and how structures may have changed to meet human needs and wants.	8.2.12.B.4
Collaborate and brainstorm with peers to solve a building / structures problem evaluating all solutions to provide the best results with supporting sketches or models.	8.2.12.C.4
Explain the function of a structural system and subsystems.	8.2.12.C.5

Design and create a prototype to solve a real world structural problem using the design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
Synthesize data, analyze trends and draw conclusions regarding the effect of a structural technology on the individual, society, or the environment and publish conclusions.	8.2.12.D.6
Apply engineering skills in a project that requires project management, process control, and quality assurance.	9.3.ST.1
Display and communicate STEM information.	9.3.ST-ET.2
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 structural plans, processes, and projects that address real world problems.	9.3.ST-SM.3
Locate, organize, and reference written information from various sources to communicate with others.	9.4.12.O.6
Use correct grammar, punctuation, and terminology to write and edit documents.	9.4.12.O.8
Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.	9.4.12.O.9
Listen to and speak with diverse individuals to enhance communication skills.	9.4.12.O.13
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19
Conduct technical research to gather information necessary for decision-making.	9.4.12.O.20
Operate internet, presentation, spreadsheet, groupware / collaboration applications to expedite workflow.	9.4.12.O.22, 9.4.12.O.24, 9.4.12.O.26, 9.4.12.O.27, 9.4.12.O.29
Develop a personalized student learning plan to meet career goals and objectives.	9.4.12.O.56

Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Apply the concepts, processes, guiding principles, and standards of school mathematics to solve structural problems.	9.4.12.O.(1).1
Demonstrate the ability to select, apply, and convert systems of measurement to solve structural problems.	9.4.12.O.(1).3
Explain relevant physical properties of structural materials used in engineering and technology.	9.4.12.O.(1).4
Design a solution to a complex real-world building / structural problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	HS-ETS1-2
Use a computer simulation to model the impact of proposed solutions to a complex real-world building / structural problem with numerous criteria and constraints on interactions and within and between systems relevant to the problem.	HS-ETS1-4
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Historical tensions between environmental and economic considerations are driven by human needs and wants in the development of a technological building product.	8.2.12.B.5
Engineers work with peers to redesign an existing building product or system for a different purpose.	8.2.12.C.7
Concepts, strategies and systems, for obtaining and conveying ideas and information to enhance communication.	9.4.12.O.5
Resources Mini Unit 2A:	Textbook Chapter 11 Textbook Chapter 17 https://bridgecontest.org/

	Balsa wood, Glue, Waxed paper, T - Pins, cardboard or project board, lengths of 2x4, bucket, graph paper, Classroom tools and supplies, Weights Stress analyzer Google Classroom Environment Google Drive Portfolio

MINI UNIT 2B	
Title:	**Mechanical Design**
Duration:	**3 weeks**
Overview:	**Students will learn how all machines and mechanisms are governed by known scientific and mathematical principles, and explore how machines and mechanisms have shaped society over time. They will get an overview of basic kinematics, engineer (or reverse engineer) a mechanism, and create a prototype to solve a specific real world problem.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
How to research and present information on an existing technological product that has been repurposed for a different function.	8.2.12.A.3
STEM knowledge is used to solve mechanical problems.	9.3.ST-ET.5
Critical thinking and interpersonal skills can be employed to resolve conflicts.	9.4.12.O.18
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs, and risks, related to the use of the innovation.	8.2.12.A.1

Brainstorm ideas on how to solve a problem or build a product.	8.2.12.C.1
Create a drawing of a product or device that communicates its function to peers and discuss.	8.2.12.C.2
Examine a malfunctioning tool and identify the process to troubleshoot and present options to repair the tool.	8.2.12.C.6
Design a create a mechanical prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a mechanical product or system.	8.2.12.D.3
Apply engineering skills in a project that requires project management, process control, and quality assurance.	9.3.ST.1
Apply processes and concepts for the use of technological tools in STEM.	9.3.ST-ET.3
Apply the elements of the design process to design a machine or mechanism.	9.3.ST-ET.4
Develop and interpret tables, charts, and figures to support written and oral communications.	9.4.12.O.12
Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.	9.4.12.O.15
Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.	9.4.12.O.17
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56

Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Explain relevant physical properties of materials used in engineering and technology.	9.4.12.O.(1).5
Explain relationships among specific scientific theories, principles, and laws that apply to mechanical engineering.	9.4.12.O.(1).6
Employ concepts and processes for the application of technology to mechanical engineering.	9.4.12.O.(1).9
Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	HS-ETS1-1
Design a solution to a complex real-world mechanical problem by breaking it down into smaller, more manageable problems that can be solved through mechanical engineering.	HS-ETS1-2
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, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	HS-ETS1-3
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Mechanical engineers 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.B.2
Material processing impacts the quality of engineered and fabricated products.	8.2.12.D.5
Breadth of career opportunities in mechanical engineering and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.	9.3.ST.5

Newton's laws of motion can be used to analyze static and dynamic systems with and without the presence of external forces.	9.4.12.O.(1).4

Resources Mini Unit 2B:	Textbook Chapter 12 https://www.robives.com/ Google Classroom Environment Google Drive Portfolio Cardstock, Glue, adhesives, gears, plywood, sandpaper, drill, saw, foam (hot wire) cutter Example mechanisms

MINI UNIT 2C	
Title:	**Electrical Design**
Duration:	**4 weeks**
Overview:	**In this unit, students will understand the exponential growth of electrical science and technology in relation to various engineering careers. After learning about basic electrical and electronic engineering, they will apply their knowledge of basic circuit design and the engineering design process, to develop, prototype, and test a new or repurposed electrical device. Students may conduct their design work in conjunction with selected competitive events.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
Electrical and electronic technologies in the information age have impacted society to change human needs and wants.	8.2.12.B.4
Electrical and electronics engineers design solutions to a complex real-world problems by breaking them down into smaller, more manageable problems that can be solved through engineering.	HS-ETS1-2
Evaluate a solution to a complex real-world electrical / electronic problem based on prioritized 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	HS-ETS1-3

impacts.	
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Research the 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 to peers for review.	8.2.12.B.5
Brainstorm ideas on how to solve a problem or build an electrical / electronic product.	8.2.12.C.1
Collaborate and brainstorm with peers to solve an electrical / electronic engineering problem evaluating all solutions to provide the best results with supporting sketches or models.	8.2.12.C.4
Explain the function of an electrical / electronic system and subsystems.	8.2.12.C.5
Work with peers to redesign an existing system or component for a different purpose.	8.2.12.C.7
Design a create a prototype to solve a real world electrical / electronic problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
Use STEM concepts and processes to solve electrical / electronic problems involving design and/or production.	9.3.ST-ET.1
Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.	9.4.12.O.9
Exhibit public relations skills in order to increase internal and external customer satisfaction.	9.4.12.O.14
During peer presentations, apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.	9.4.12.O.16
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19

Use computer-based equipment containing embedded computers or processors to control devices.	9.4.12.O.31
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Use scientific and mathematical problem-solving skills and abilities to develop realistic solutions to assigned projects, and illustrate how science and mathematics impact problem-solving in modern society.	9.4.12.O.(2).4
Demonstrate the knowledge and technical skills needed to obtain and succeed in a chosen scientific and mathematical field.	9.4.12.O.(2).6
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Electrical / electronic engineering requires project management, process control, and quality assurance skills when working independently and in a team.	9.3.ST.1
Electrical / electronics engineers work through the design process by applying knowledge and skill in STEM to solve problems.	9.3.ST-ET.4, 9.3.ST-ET.5
Electrical / electronics engineers conduct and participate in meetings to accomplish tasks.	9.4.12.O.50
Resources Mini Unit 2C:	Textbook Chapter 13 Dueck, R. & Reid, K. *Digital Electronics, 1st Edition*. (2012). Clifton Park, NY: Delmar Cengage Learning. ISBN-13: 978-1439060001 Assorted Batteries, Wire, Switches, Motors, Soldering tools and materials,pliers, heat shrink, heat gun, Classroom tools & supplies, Resistors, Capacitors, Inductors, LEDs, Voltmeter, Assorted design materials Google Classroom Environment Google Drive Portfolio

UMBRELLA UNIT 3	
Title:	Applied Engineering: Integrated Systems
Duration:	9 weeks
Essential Questions:	How is computer modeling used in different engineering fields? How does rapid prototyping work? What kind of tests would you develop to evaluate the success of your design work? What kinds of tests do engineers use to test product materials for tensile strength, fatigue, and hardness? Why do you think that product testing typically includes looking at aesthetics, ergonomics, safety, and durability? How can assessing the way in which you went about your work help you evaluate your own design work? How do liquids and gases differ under pressure and how can we take advantage of these characteristics? How do hydraulic and pneumatic systems work? How do pneumatic systems create mechanical advantage and develop enormous force? How are fluid systems designed and how are forces, area, volume, and distance of travel calculated?
Summative Assessments: **(Assessment at the end the learning period)**	Summative Assessment #3: critical thinking questions & project-based component Online Portfolio Review Personalized Student Learning Plan assessment - Unit 3
Formative Assessments: **(Ongoing assessments during the learning period)**	Chapter / unit quiz Exit tickets Do Now exercises Student self-assessments / reflections Personalized Student Learning Plan goal monitoring
Differentiation:	Varied delivery formats: lecture, video, self-guided research, group discussion, think-pair-share Graphic organizers & infographics Enhancing existing portfolio Independent research Journal reflection Design critiques Group presentation or graphic display (i.e., poster, alternative media)

	Student choice / student goal planning and management Metacognitive strategies based on student's interests and background knowledge Design circles / flexible grouping Exit tickets as formative assessment Tiered tests
TECHNOLOGY STANDARD (STANDARD 8)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
8.2.12.A.1	Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.
8.2.12.A.2	Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability, and waste.
8.2.12.B.1	Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.
8.2.12.B.2	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.C.1	Brainstorm ideas on how to solve a problem or build a product.
8.2.12.C.2	Create a drawing of a product or device that communicates its function to peers and discuss.
8.2.12.C.4	Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models.
8.2.12.C.5	Explain the function of a system and subsystems.
8.2.12.C.6	Examine a malfunctioning tool and identify the process to troubleshoot and present options to repair the tool.
8.2.12.C.7	Work with peers to redesign an existing product for a different purpose.
8.2.12.D.1	Design a create a prototype to solve a real world problem using a design process, identify constraints addressed

	during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
8.2.12.D.3	Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.
8.2.12.D.4	Assess the impacts of emerging technologies on developing countries.
8.2.12.D.5	Explain how material processing impacts the quality of engineered and fabricated products.
8.2.12.D.6	Synthesize data, analyze trends and draw conclusions regarding the effect of a technology on the individual, society, or the environment and publish conclusions.
21ST CENTURY LIFE AND CAREER (STANDARD 9)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
9.3.ST.1	Apply engineering skills in a project that requires project management, process control, and quality assurance.
9.3.ST.2	Use technology to acquire, manipulate, analyze and report data.
9.3.ST.4	Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.
9.3.ST.6	Demonstrate the technical skills needed in a chosen STEM field.
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-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.
9.3.ST-SM.4	Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret, and summarize research and statistical data.
9.4.12.O.4	Select and employ appropriate reading and communication strategies to learn and use technical concepts and vocabulary in practice.
9.4.12.O.5	Demonstrate use of the concepts, strategies, and systems for obtaining and conveying ideas and information to enhance communication.
9.4.12.O.6	Locate, organize, and reference written information from various sources to communicate with others.
9.4.12.O.7	Evaluate and use information resources to accomplish specific occupational tasks.
9.4.12.O.9	Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.
9.4.12.O.12	Develop and interpret tables, charts, and figures to support written and oral communications.
9.4.12.O.13	Listen to and speak with diverse individuals to enhance communication skills.
9.4.12.O.15	Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.
9.4.12.O.16	Apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.
9.4.12.O.17	Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.
9.4.12.O.19	Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.
9.4.12.O.20	Conduct technical research to gather information necessary for decision-making.
9.4.12.O.22	Employ technological tools to expedite workflow.
9.4.12.O.24	Operate Internet applications to perform tasks.

9.4.12.O.27	Employ spreadsheet applications to organize and manipulate data.
9.4.12.O.29	Employ collaborative / groupware applications to facilitate group work.
9.4.12.O.31	Use computer-based equipment containing embedded computers or processors to control devices.
9.4.12.O.32	Effectively use information technology to gather, store, and communicate data in appropriate formats.
9.4.12.O.33	Evaluate and demonstrate skill with a range of technological tools designed to manipulate, report, or operate with data acquisition.
9.4.12.O.36	Examine and summarize roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment to understand the nature and scope of organizations in this cluster.
9.4.12.O.46	Employ leadership skills to accomplish goals and objectives.
9.4.12.O.47	Employ organizational skills to foster positive working relationships and accomplish organizational goals.
9.4.12.O.48	Employ teamwork skills to achieve collective goals and use team members' talents effectively.
9.4.12.O.49	Establish and maintain effective relationships in order to accomplish objectives and tasks.
9.4.12.O.50	Conduct and participate in meetings to accomplish tasks.
9.4.12.O.52	Apply ethical reasoning to a variety of situations in order to make ethical decisions.
9.4.12.O.56	Develop a Personalized Student Learning Plan to meet career goals and objectives.
9.4.12.O.57	Demonstrate skills related to seeking and applying for employment in a desired job.
9.4.12.O.58	Maintain a career portfolio to document knowledge, skills, and experience in a career field.
9.4.12.O.61	Identify and explore careers in one or more career pathways to build an understanding of the opportunities in the cluster.
9.4.12.O.66	Select, research, and examine critical aspects of career opportunities in one or more pathways to gain an understanding of the breadth of occupations within this cluster.
9.4.12.O.67	Employ information management techniques and strategies to assist in decision-making.

9.4.12.O.68	Employ planning and time management skills and tools to enhance results and complete work tasks.
9.4.12.O.(1).1	Apply the concepts, processes, guiding principles, and standards of school mathematics to solve science, technology, engineering, and mathematics problems.
9.4.12.O.(1).2	Apply and use algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve problems.
9.4.12.O.(1).3	Demonstrate the ability to select, apply, and convert systems of measurement to solve problems.
9.4.12.O.(1).4	Demonstrate the ability to use Newton's laws of motion to analyze static and dynamic systems with and without the presence of external forces.
9.4.12.O.(1).5	Explain relevant physical properties of materials used in engineering and technology.
9.4.12.O.(1).6	Explain relationships among specific scientific theories, principles, and laws that apply to technology and engineering.
9.4.12.O.(1).7	Use mathematics, science, and technology concepts and processes to solve problems in projects involving design and/or production (e.g., medical, agricultural, biotechnological, energy and power, information and communication, transportation, manufacturing, and construction).
9.4.12.O.(1).8	Select and use a range of communications technologies, including word processing, spreadsheet, database, presentation, email, and Internet applications, to locate and display information.
9.4.12.O.(1).9	Employ concepts and processes for the application of technology to engineering.
9.4.12.O.(1).11	Demonstrate understanding of processes and concepts that are key to understanding the design process.
9.4.12.O.(1).12	Model technical competence by developing and applying processes and concepts in the design process.
9.4.12.O.(2).1	Develop an understanding of how science and mathematics function to provide results, answers, and algorithms for engineering activities to solve problems and issues in the real world.
9.4.12.O.(2).2	Apply science and mathematics when developing plans, processes, and projects to find solutions to real world problems.
9.4.12.O.(2).3	Assess the impact that science and mathematics have on society when used to develop projects or products.
9.4.12.O.(2).4	Use scientific and mathematical problem-solving skills and abilities to develop realistic solutions to assigned projects,

	and illustrate how science and mathematics impact problem-solving in modern society.
9.4.12.O.(2).5	Demonstrate critical thinking abilities and skills needed to review information, to explain statistical analyses, and to translate, interpret, and summarize research and statistical data collected and analyzed as the result of an investigation.
9.4.12.O.(2).6	Demonstrate the knowledge and technical skills needed to obtain and succeed in a chosen scientific and mathematical field.
NEXT GENERATION SCIENCE STANDARDS (HS-ETS1 ENGINEERING DESIGN)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
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, 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.

MINI UNIT 3A	
Title:	**Design & Prototyping**
Duration:	**3 weeks**
Overview:	**In this unit, students will be able to select a real-world engineering design problem that fits their**

	personal interest. This may be an extension of their previous designs from Unit 2, or a new project in another engineering discipline. They will construct a design brief, developing and monitoring goals and progress throughout the design process. Students will use software and web-based CAD applications to develop a solution, creating a prototype of their design and engaging in multiple peer critique sessions.

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
How to 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.B.2
How to analyze the impact that science and mathematics has on society.	9.3.12.ST-SM.3
Specific skills are required for seeking and applying for employment in a desired job.	9.4.12.O.57
Relevant physical properties of materials used in engineering and technology.	9.4.12.O.(1).5
Relationships among specific scientific theories, principles, and laws can be applied to technology and engineering.	9.4.12.O.(1).6
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.	8.2.12.A.1
Brainstorm ideas on how to solve a problem or build a product.	8.2.12.C.1
Create a drawing of a product or device that communicates its function to peers and discuss.	8.2.12.C.2
Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models.	8.2.12.C.4
Design a create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1

Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.	8.2.12.D.3
Assess the impacts of emerging technologies on developing countries.	8.2.12.D.4
Explain how material processing impacts the quality of engineered and fabricated products.	8.2.12.D.5
Demonstrate the technical skills needed in a chosen STEM field.	9.3.12.ST.6
Use STEM concepts and processes to solve problems involving design and/or production.	9.3.ST-ET.1
Display and communicate STEM information.	9.3.12.ST-ET.2
Apply processes and concepts for the use of technological tools in STEM, elements of the design process, and the knowledge learned in STEM to solve problems.	9.3.12.ST-ET.3, 9.3.12.ST-ET.4, 9.3.12.ST-ET.5
Apply science and mathematics concepts to the development of plans, processes, and projects that address real world problems.	9.3.12.ST-SM.2
Listen to and speak with diverse individuals to enhance communication skills.	9.4.12.O.13
Apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.	9.4.12.O.16
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19
Conduct technical research to gather information necessary for decision-making.	9.4.12.O.20
Employ technological tools to expedite workflow.	9.4.12.O.22
Operate Internet applications to perform tasks.	9.4.12.O.24
Use computer-based equipment containing embedded computers or processors to control devices.	9.4.12.O.31

Effectively use information technology to gather, store, and communicate data in appropriate formats.	9.4.12.O.32
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Apply and use algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve problems.	9.4.12.O.(1).2
Demonstrate the ability to select, apply, and convert systems of measurement to solve problems.	9.4.12.O.(1).3
Use mathematics, science, and technology concepts and processes to solve problems in projects involving design and/or production (e.g., medical, agricultural, biotechnological, energy and power, information and communication, transportation, manufacturing, and construction).	9.4.12.O.(1).7
Employ concepts and processes for the application of technology to engineering.	9.4.12.O.(1).9
Model technical competence by developing and applying processes and concepts in the design process.	9.4.12.O.(1).12
Apply science and mathematics when developing plans, processes, and projects to find solutions to real world problems.	9.4.12.O.(2).2
Use scientific and mathematical problem-solving skills and abilities to develop realistic solutions to assigned projects, and illustrate how science and mathematics impact problem-solving in modern society.	9.4.12.O.(2).4
Demonstrate the knowledge and technical skills needed to obtain and succeed in a chosen scientific and mathematical field.	9.4.12.O.(2).6
Analyze a major global challenge to specify qualitative and quantitative criteria and	HS-ETS1-1

constraints for solutions that account for societal needs and wants.	
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-ETS1-2
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.	HS-ETS1-4
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Engineers apply their skills in projects that require project management, process control, and quality assurance.	9.3.ST.1
The nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.	9.3.ST.4
Engineers use concepts, strategies, and systems for obtaining and conveying ideas and information to enhance communication.	9.4.12.O.5
Critical aspects of career opportunities in one or more pathways to gain an understanding of the breadth of occupations within this cluster.	9.4.12.O.66
Processes and concepts that are key to understanding the design process.	9.4.12.O.(1).11
Resources Mini Unit 3A:	Textbook Chapter 4, 7 Engineering Fundamentals: Chapter 2, 5 Autodesk Design Suite Google Classroom Environment Google Drive Portfolio 3D printer, laser cutter, CNC machine, classroom tools and materials

MINI UNIT 3B	
Title:	**Testing, Analysis & Redesign**
Duration:	**2 weeks**
Overview:	**Students will continue to develop their design from Unit 3.A, using the step of the engineering design process. They will create their own testing and analysis methods and processes, and monitor success and failure throughout the process. Students will redesign and evaluate their projects based on engineering knowledge and skills. Students will learn about social, political, economical, aesthetic, and functional factors critical to successful design.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
Problem solving in a collaborative environment requires evaluating all solutions to provide the best results.	8.2.12.C.4
A successful design is comprised of a system and various subsystems, all of which have specific functions.	8.2.12.C.5
Engineers apply elements of the design process.	9.3.ST-ET.4
Engineers evaluate and demonstrate skill with a range of technological tools designed to manipulate, report, or operate with data acquisition.	9.4.12.O.33
Science and mathematics have a significant impact on society when used to develop products or projects.	9.4.12.O.(2).3
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability, and waste.	8.2.12.A.2
Work with peers to redesign an existing product for a different purpose.	8.2.12.C.7
Synthesize data, analyze trends and draw conclusions regarding the effect of a	8.2.12.D.6

technology on the individual, society, or the environment and publish conclusions.	
Use technology to acquire, manipulate, analyze and report data.	9.3.ST.2
Apply science and mathematics to provide results, answers and algorithms for engineering and technological activities.	9.3.ST-SM.1
Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret, and summarize research and statistical data.	9.3.ST-SM.4
Select and employ appropriate reading and communication strategies to learn and use technical concepts and vocabulary in practice.	9.4.12.O.4
Locate, organize, and reference written information from various sources to communicate with others.	9.4.12.O.6
Evaluate and use information resources to accomplish specific occupational tasks.	9.4.12.O.7
Develop and interpret tables, charts, and figures to support written and oral communications.	9.4.12.O.12
Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.	9.4.12.O.15
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19
Conduct technical research to gather information necessary for decision-making.	9.4.12.O.20
Employ spreadsheet applications to organize and manipulate data.	9.4.12.O.27
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56
Demonstrate skills related to seeking and applying for employment in a desired job.	9.4.12.O.57
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58

Employ information management techniques and strategies to assist in decision-making.	9.4.12.O.67
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Apply the concepts, processes, guiding principles, and standards of school mathematics to solve science, technology, engineering, and mathematics problems.	9.4.12.O.(1).1
Select and use a range of communications technologies, including word processing, spreadsheet, database, presentation, email, and Internet applications, to locate and display information.	9.4.12.O.(1).8
Demonstrate critical thinking abilities and skills needed to review information, to explain statistical analyses, and to translate, interpret, and summarize research and statistical data collected and analyzed as the result of an investigation.	9.4.12.O.(2).5
Demonstrate the knowledge and technical skills needed to obtain and succeed in a chosen scientific and mathematical field.	9.4.12.O.(2).6
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, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	HS-ETS1-3
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Engineers must research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need.	8.2.12.B.1
Engineers real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
Engineers use STEM concepts and processes to solve problems involving design and/or production.	9.3.ST-ET.1
Engineers employ leadership skills to accomplish goals and objectives, and	9.4.12.O.46, 9.4.12.O.47

organizational skills to foster positive working relationships.	
Engineers apply ethical reasoning to a variety of situations in order to make ethical decisions.	9.4.12.O.52
Relationships among specific scientific theories, principles, and laws that apply to technology and engineering.	9.4.12.O.(1).6
Resources Mini Unit 3B:	Textbook Chapter 9 Engineering Fundamentals: Chapter 6 Google Classroom Environment Google Drive Portfolio

MINI UNIT 3C	
Title:	**Fluid Power**
Duration:	**4 weeks**
Overview:	**Students will explore properties of hydraulic and pneumatic systems and how they are used in engineering design. They will learn about how liquids and gases perform differently in pressurized systems, and how engineers distinguish between and take advantage of these characteristics. Students will utilize the engineering design process, developing their own design brief and project goals, for a hydraulic system. Students will work in teams to demonstrate the principles of pneumatics. They will present their results to the class for review and evaluation.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
Engineering design of fluid systems requires project management, process control, and quality assurance.	9.3.ST.1

Essential Outcomes - Upon completion of this course students will be able to (procedural):	Alignment to Standards
Brainstorm ideas on how to solve a fluid problem or build a product.	8.2.12.C.1
Create a drawing of a fluid device that communicates its function to peers and discuss.	8.2.12.C.2
Collaborate and brainstorm with peers to solve a fluid problem evaluating all solutions to provide the best results with supporting sketches or models.	8.2.12.C.4
Explain the function of a fluid system and subsystems.	8.2.12.C.5
Work with peers to redesign an existing product for a different purpose.	8.2.12.C.7
Design a create a prototype to solve a real world fluid power problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
Use STEM concepts and processes to solve fluid power problems involving design and/or production.	9.3.12.ST-ET.1
Apply the elements of the design process to a fluid power engineering problem.	9.3.12.ST-ET.4
Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.	9.4.12.O.9
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19
Employ collaborative / groupware applications to facilitate group work.	9.4.12.O.29
Effectively use information technology to gather, store, and communicate data in appropriate formats.	9.4.12.O.32
Employ leadership skills to accomplish goals and objectives.	9.4.12.O.46
Employ organizational skills to foster positive working relationships and accomplish organizational goals.	9.4.12.O.47

Employ teamwork skills to achieve collective goals and use team members' talents effectively.	9.4.12.O.48
Establish and maintain effective relationships in order to accomplish objectives and tasks.	9.4.12.O.49
Conduct and participate in meetings to accomplish tasks.	9.4.12.O.50
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Employ planning and time management techniques and strategies to assist in decision-making.	9.4.12.O.68
Apply and use algebraic, geometric, and trigonometric relationships, characteristics, and properties to solve fluid power problems.	9.4.12.O.(1).2
Demonstrate the ability to select, apply, and convert systems of measurement to solve fluid power problems.	9.4.12.O.(1).3
Demonstrate the ability to use Newton's laws of motion to analyze static and dynamic systems with and without the presence of external forces.	9.4.12.O.(1).4
Use mathematics, science, and technology concepts and processes to solve fluid power problems in projects involving design and/or production (e.g., medical, agricultural, biotechnological, energy and power, information and communication, transportation, manufacturing, and construction).	9.4.12.O.(1).7
Model technical competence by developing and applying processes and concepts in the fluid power design process.	9.4.12.O.(1).12
Analyze a major fluid power challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	HS-ETS1-1
Design a solution to a complex real-world fluid power problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	HS-ETS1-2

Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Current pneumatic and hydraulic technologies and the resources used,and the trade-offs in terms of availability, cost, desirability, and waste.	8.2.12.A.2
Solving fluid power problems, independently and in teams, requires critical thinking skills (analysis, synthesis, and evaluation).	9.4.12.O.17
Roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment to understand the nature and scope of organizations in this cluster.	9.4.12.O.36
Relevant physical properties of materials used in engineering and technology.	9.4.12.O.(1).5
Relationships among specific scientific theories, principles, and laws that apply to technology and engineering.	9.4.12.O.(1).6

Resources Mini Unit 3C:	Textbook Chapter 14 Engineering Fundamentals: Chapter 10 Google Classroom Environment Google Drive Portfolio Syringes, polyurethane or silicone tubing, connectors, adhesives, plywood, rigid foam insulation, foam core board, wood dowels, miscellaneous materials, fasteners, hand tools, power tools

UMBRELLA UNIT 4	
Title:	Human Factors in Design and Engineering
Duration:	10 weeks
Essential Questions:	What are human factors? How do engineers design for human factors? Why is it necessary to understand human factors to be a successful designer/engineer? How are anthropometric data used during the design process? How are principles of human behavior and abilities applied during the design process? How can universal design principles help everyone? What steps are used in human factors design? How is a design evaluated for safety, comfort, and effective human use? How does bioengineering impact society? How do engineers synthesize and apply knowledge in materials, chemical, mechanical and electrical engineering to solve bioengineering problems? Why is it imperative to understand ethical factors in design and problem solving? What careers and opportunities are available to bioengineers? Why are graphics important to successful product design and effective professional presentations?
Summative Assessments: **(Assessment at the end the learning period)**	Summative Assessment #4: critical thinking questions & project-based component Completed Portfolio Website Personalized Student Learning Plan assessment - Unit 4 Independent Project Evaluation Final Exam: Engineering Disciplines Survey: student-created video
Formative Assessments: **(Ongoing assessments during the learning period)**	Chapter / unit quiz Exit tickets Do Now exercises Student self-assessments / reflections Personalized Student Learning Plan goal monitoring
Differentiation:	Varied delivery formats: lecture, video, self-guided research, group discussion, think-pair-share Graphic organizers & infographics Enhancing existing portfolio Independent research

	Journal reflection Design critiques Group presentation or graphic display (i.e., poster, alternative media) Student choice / student goal planning and management Metacognitive strategies based on student's interests and background knowledge Design circles / flexible grouping Exit tickets as formative assessment Tiered tests
TECHNOLOGY STANDARD (STANDARD 8)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
8.2.12.A.1	Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.
8.2.12.A.2	Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability, and waste.
8.2.12.A.3	Research and present information on an existing technological product that has been repurposed for a different function.
8.2.12.B.1	Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.
8.2.12.B.2	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.B.3	Analyze ethical and unethical practices around intellectual property rights as influenced by human wants and/or needs.
8.2.12.C.1	Brainstorm ideas on how to solve a problem or build a product.
8.2.12.C.2	Create a drawing of a product or device that communicates its function to peers and discuss.
8.2.12.C.3	Explain why we need to make new products.
8.2.12.C.4	Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with

	supporting sketches or models.
8.2.12.C.5	Explain the function of a system and subsystems.
8.2.12.C.6	Examine a malfunctioning tool and identify the process to troubleshoot and present options to repair the tool.
8.2.12.C.7	Work with peers to redesign an existing product for a different purpose.
8.2.12.D.1	Design a create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
8.2.12.D.2	Write a feasibility study of a product to include: economic, market, technical, financial, and management factors, and provide recommendations for implementation.
8.2.12.D.3	Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.
8.2.12.D.4	Assess the impacts of emerging technologies on developing countries.
8.2.12.D.5	Explain how material processing impacts the quality of engineered and fabricated products.
8.2.12.D.6	Synthesize data, analyze trends and draw conclusions regarding the effect of a technology on the individual, society, or the environment and publish conclusions.
21ST CENTURY LIFE AND CAREER (STANDARD 9)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
9.3.ST.1	Apply engineering skills in a project that requires project management, process control, and quality assurance.
9.3.ST.4	Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.
9.3.ST.5	Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.
9.3.ST.6	Demonstrate the technical skills needed in a chosen STEM field.
9.3.ST-ET.1	Use STEM concepts and processes to solve problems involving design and/or production.

9.3.ST-ET.3	Apply processes and concepts for the use of technological tools in STEM.
9.3.ST-ET.4	Apply the elements of the design process.
9.3.ST-ET.5	Apply the knowledge learned in STEM to solve problems.
9.3.ST-ET.6	Apply the knowledge learned in the study of STEM to provide solutions to human and societal problems in an ethical and legal manner.
9.3.ST-SM.2	Apply science and mathematics concepts to the development of plans, processes, and projects that address real world problems.
9.4.12.O.9	Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.
9.4.12.O.11	Apply active listening skills to obtain and clarify information.
9.4.12.O.13	Listen to and speak with diverse individuals to enhance communication skills.
9.4.12.O.14	Exhibit public relations skills in order to increase internal and external customer satisfaction.
9.4.12.O.15	Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.
9.4.12.O.16	Apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.
9.4.12.O.17	Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.
9.4.12.O.19	Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.
9.4.12.O.20	Conduct technical research to gather information necessary for decision-making.
9.4.12.O.36	Examine and summarize roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment to understand the nature and scope of organizations in this cluster.
9.4.12.O.46	Employ leadership skills to accomplish goals and objectives.
9.4.12.O.49	Establish and maintain effective relationships in order to accomplish objectives and tasks.

9.4.12.O.50	Conduct and participate in meetings to accomplish tasks.
9.4.12.O.52	Apply ethical reasoning to a variety of situations in order to make ethical decisions.
9.4.12.O.54	Demonstrate workplace ethics specific to occupations in this cluster in order to reflect effective stewardship of resources.
9.4.12.O.55	Identify and demonstrate positive work behaviors and personal qualities needed to succeed in the classroom and/or to be employable.
9.4.12.O.56	Develop a Personalized Student Learning Plan to meet career goals and objectives.
9.4.12.O.58	Maintain a career portfolio to document knowledge, skills, and experience in a career field.
9.4.12.O.59	Demonstrate skills in evaluating and comparing employment opportunities in order to accept employment positions that match career goals.
9.4.12.O.61	Identify and explore careers in one or more career pathways to build an understanding of the opportunities in the cluster.
9.4.12.O.62	Examine requirements for career advancement to plan for continuing education and training.
9.4.12.O.63	Research professional development opportunities needed to keep current on relevant trends and information within the cluster.
9.4.12.O.64	Examine licensing, certification, and credentialing requirements at the national, state, and local levels to maintain compliance with industry requirements.
9.4.12.O.65	Examine employment opportunities in entrepreneurship as an option for career planning.
9.4.12.O.66	Select, research, and examine critical aspects of career opportunities in one or more pathways to gain an understanding of the breadth of occupations within this cluster.
9.4.12.O.67	Employ information management techniques and strategies to assist in decision-making.
9.4.12.O.68	Employ planning and time management skills and tools to enhance results and complete work tasks.
9.4.12.O.(1).3	Demonstrate the ability to select, apply, and convert systems of measurement to solve problems.

9.4.12.O.(1).5	Explain relevant physical properties of materials used in engineering and technology.
9.4.12.O.(1).6	Explain relationships among specific scientific theories, principles, and laws that apply to technology and engineering.
9.4.12.O.(1).7	Use mathematics, science, and technology concepts and processes to solve problems in projects involving design and/or production (e.g., medical, agricultural, biotechnological, energy and power, information and communication, transportation, manufacturing, and construction).
9.4.12.O.(1).9	Employ concepts and processes for the application of technology to engineering.
NEXT GENERATION SCIENCE STANDARDS (HS-ETS1 ENGINEERING DESIGN)	
CPI #	**CUMULATIVE PROGRESS INDICATOR (CPI)**
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, 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.

MINI UNIT 4A	
Title:	**Ergonomics & Product Development**
Duration:	**2 weeks**
Overview:	**Students will learn that human factors are human physical characteristics, behavior, and abilities that provide a body of knowledge applied to the design of products, systems, and environments for**

	safe and effective use. Students will examine various tools and product designs to analyze the impact of human factors in design, with a focus on communication and customer satisfaction . Using the engineering design process and/or reverse engineering, students will apply human factor design to a product and publish their results.

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
Engineers brainstorm ideas on how to make new products, with a focus on ergonomics.	8.2.12.C.1
Engineers create technical drawings and CAD models of products that communicate their function to peers, and discuss to make improvements.	8.2.12.C.2
Engineers use STEM concepts and processes to solve problems involving ergonomic design.	9.3.ST-ET.1
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Propose an innovation in ergonomics/product development to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, and human factors related to the use of the innovation.	8.2.12.A.1
Analyze a current technology in ergonomics / product development and the resources used, to identify the trade-offs in terms of availability, cost, desirability, and waste.	8.2.12.A.2
Research and present information on an existing technological product that has been repurposed for a different function, with a focus on ergonomics / anthropometrics.	8.2.12.A.3
Examine a malfunctioning tool and identify the process to troubleshoot and present options to improve ergonomics and function.	8.2.12.C.6
Work with peers to redesign an existing product for a different purpose, with a focus on ergonomics.	8.2.12.C.7
Design a create a prototype to solve a real world problem using a design process, identify ergonomic constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1

Assess the impacts of emerging technologies on developing countries.	8.2.12.D.4
Explain how material processing impacts the quality of engineered and fabricated products when designed with human factors in mind.	8.2.12.D.5
Apply the elements of the design process.	9.3.12.ST-ET.4
Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.	9.4.12.O.9
Apply active listening skills to obtain and clarify information.	9.4.12.O.11
Listen to and speak with diverse individuals to enhance communication skills.	9.4.12.O.13
Apply active listening skills to obtain or clarify information pertaining to plans, processes, projects, or designs.	9.4.12.O.16
Identify, write, and monitor performance goals to guide progress in assigned areas of responsibility and accountability.	9.4.12.O.19
Establish and maintain effective relationships in order to accomplish objectives and tasks.	9.4.12.O.49
Conduct and participate in meetings to accomplish tasks.	9.4.12.O.50
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Demonstrate skills in evaluating and comparing employment opportunities in order to accept employment positions that match career goals, in ergonomics / product design.	9.4.12.O.59
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Demonstrate the ability to select, apply, and convert systems of measurement to solve anthropometric problems.	9.4.12.O.(1).3

Explain relevant physical properties of materials used in engineering and technology.	9.4.12.O.(1).5
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, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	HS-ETS1-3
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Collaboration and brainstorming with peers helps to solve problems by evaluating all possible solutions to provide the best results.	8.2.12.C.4
Science and mathematics concepts can be applied in the development of plans, processes, and projects that address real world projects.	9.3.ST-SM.2
Engineers must understand and be flexible in their designs for diverse individuals with diverse anthropometric needs and design criteria.	8.2.12.A.1, 9.3.ST-ET.6
Resources Mini Unit 4A:	Textbook Chapter 15 Google Classroom Environment Google Drive Portfolio Engineering notebook Computer Web browser CAD modeling software Assorted materials / repurposed materials

MINI UNIT 4B	
Title:	**Bioengineering**
Duration:	**4 weeks**
Overview:	**Opportunities are provided that will enable students to gain insights into the field of Bioengineering and its related technologies. Students will be presented with a bioengineering problem and will apply the steps of the Engineering Design Process to solve. Student teams will produce and present analytic calculations,ethical reasoning, verbal interpretation, and a 3D physical model or computer-generated model of their design.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
Bioengineers are always working to design and develop new products.	8.2.12.C.3
Bioengineers must be able to explain relationships among specific theories, principles, and laws that apply to technology and engineering.	9.4.12.O.(1).6
Mathematics, science and technology concepts and processes are used to help solve problems in projects involving design and/or production (e.g. biotechnology, bioengineering).	9.4.12.O.(1).7
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Propose a bioengineering innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.	8.2.12.A.1
Research and analyze the impact of the design constraints (specifications and limits) for a biotechnological product driven by a cultural, social, economic or political need and publish for review.	8.2.12.B.1
Analyze ethical and unethical practices around intellectual property rights as influenced by human wants and/or needs.	8.2.12.B.3

Brainstorm ideas on how to solve a bioengineering problem or build a product.	8.2.12.C.1
Collaborate and brainstorm with peers to solve a bioengineering problem evaluating all solutions to provide the best results with supporting sketches or models.	8.2.12.C.4
Explain the function of a biotechnology system and subsystems.	8.2.12.C.5
Design a create a prototype to solve a real world bioengineering problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
Write a feasibility study of a biotechnology product to include: economic, market, technical, financial, and management factors, and provide recommendations for implementation.	8.2.12.D.2
Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a biotechnological product or system.	8.2.12.D.3
Assess the impacts of emerging biotechnologies on developing countries.	8.2.12.D.4
Synthesize data, analyze trends and draw conclusions regarding the effect of a biotechnology on the individual, society, or the environment and publish conclusions.	8.2.12.D.6
Apply bioengineering skills in a project that requires project management, process control, and quality assurance.	9.3.ST.1
Apply the knowledge learned in the study of STEM to provide solutions to human and societal bioengineering problems in an ethical and legal manner.	9.3.ST-ET.6
Apply science and mathematics concepts to the development of plans, processes, and projects that address real world bioengineering problems.	9.3.ST-SM.2
Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.	9.4.12.O.9
Exhibit public relations skills in order to increase internal and external customer satisfaction.	9.4.12.O.14

Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.	9.4.12.O.15
Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve bioengineering problems and make decisions.	9.4.12.O.17
Conduct technical research to gather information necessary for decision-making.	9.4.12.O.20
Apply ethical reasoning to a variety of situations in order to make ethical decisions.	9.4.12.O.52
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Demonstrate skills in evaluating and comparing employment opportunities in order to accept employment positions that match career goals.	9.4.12.O.59
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Employ concepts and processes for the application of biotechnology to engineering.	9.4.12.O.(1).9
Analyze a major global bioengineering challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	HS-ETS1-1
Design a solution to a complex real-world bioengineering problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	HS-ETS1-2
Evaluate a solution to a complex real-world bioengineering problem based on prioritized 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-ETS1-3
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Bioengineering requires evaluating ethical considerations regarding the sustainability of	8.2.12.B.2

environmental resources that are used for the design, creation, and maintenance of a chosen product.	
Bioengineering requires applying processes and concepts for the use of technological tools in STEM, applying the elements of the design process, and applying the knowledge learned in STEM to solve problems.	9.3.ST-ET.3, 9.3.ST-ET.4, 9.3.ST-ET.5
Resources Mini Unit 4B:	Engineering Foundations: Chapter 11 Google Classroom Environment Google Drive Portfolio Engineering notebook Computer Web browser CAD modeling software plastic, elastic, metal, cardboard, paper, plaster, velcro, wire, fasteners, string, fabric, CAD/CAM materials, sculpting tools, sandpaper, paintbrushes, knives, files, wire cutters, hand drills, modeling tools, plastic wrap, packing tape, newspaper, tape cutter

MINI UNIT 4C	
Title:	**Independent Project**
Duration:	**4 weeks**
Overview:	**In this final mini-unit, students will demonstrate their mastery of engineering thinking and the design process. Students will advance their understanding of engineering through an exploration of multiple engineering fields in this capstone unit. Students will identify an open-ended, complex real-world problem, and apply the Engineering Design Process to arrive at a solution. They will document their progress through sketching, technical drawing, 3D physical models, computer-generated models, data analysis, evaluation and redesign. Students will discover how they can utilise graphic design principles to enhance product design and make more effective personal presentations.**

Essential Outcomes - Upon completion of this course students will know (declarative):	**Alignment to Standards**
The requirements for career advancement to plan for continuing education and training.	9.4.12.O.62
The professional development opportunities needed to keep current on relevant trends and information within a career cluster.	9.4.12.O.63
Licensing, certification, and credentialing requirements at the national, state, and local levels to maintain compliance with industry requirements.	9.4.12.O.64
Entrepreneurship is an option for career planning.	9.4.12.O.65
Essential Outcomes - Upon completion of this course students will be able to (procedural):	**Alignment to Standards**
Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.	8.2.12.A.1
Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.	8.2.12.B.1
Write a feasibility study of a product to include: economic, market, technical, financial, and management factors, and provide recommendations for implementation.	8.2.12.D.2
Apply engineering skills in a project that requires project management, process control, and quality assurance.	9.3.ST.1
Demonstrate the technical skills needed in a chosen STEM field.	9.3.ST.6
Apply the elements of the design process.	9.3.ST-ET.4
Apply the knowledge learned in STEM to solve problems.	9.3.ST-ET.5
Develop and deliver formal and informal presentations using appropriate media to engage and inform audiences.	9.4.12.O.9

Prepare science, technology, engineering, and mathematics material in oral, written, or visual formats to provide information to an intended audience and to fulfill the specific needs of that audience.	9.4.12.O.15
Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.	9.4.12.O.17
Employ leadership skills to accomplish goals and objectives.	9.4.12.O.46
Demonstrate workplace ethics specific to occupations in this cluster in order to reflect effective stewardship of resources.	9.4.12.O.54
Identify and demonstrate positive work behaviors and personal qualities needed to succeed in the classroom and/or to be employable.	9.4.12.O.55
Develop a Personalized Student Learning Plan to meet career goals and objectives.	9.4.12.O.56
Maintain a career portfolio to document knowledge, skills, and experience in a career field.	9.4.12.O.58
Demonstrate skills in evaluating and comparing employment opportunities in order to accept employment positions that match career goals.	9.4.12.O.59
Employ planning and time management skills and tools to enhance results and complete work tasks.	9.4.12.O.68
Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	HS-ETS1-1
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-ETS1-2
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, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	HS-ETS1-3
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	HS-ETS1-4

between systems relevant to the problem.	
Essential Outcomes - Upon completion of this course students will understand (conceptual):	**Alignment to Standards**
Engineers design and create prototypes to solve real world problems using a design process. They identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.	8.2.12.D.1
The nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.	9.3.ST.4
The breadth of career opportunities and means to those opportunities in each of the Science, Technology, Engineering & Mathematics Career Pathways.	9.3.ST.5
The nature and scope of organizations in this cluster, including roles within teams, work units, departments, organizations, inter-organizational systems, and the larger environment.	9.4.12.O.36
The breadth of occupations and opportunities in one or more career pathways.	9.4.12.O.61, 9.4.12.O.66
Resources Mini Unit 4C:	Textbook Chapter 18 Google Classroom Environment Google Drive Portfolio Media creation software Engineering notebook Computer Web browser CAD modeling software

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